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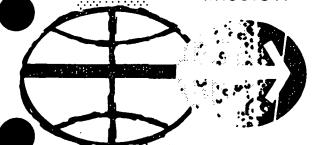
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NASA/DOD EARTH ORBIT
SHUTTLE TRAFFIC MODELS
BASED ON END-TO-END
LOADING OF PAYLOADS

Flight Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION



MANNED SPACECRAFT CENTER
HOUSTON.TEXAS

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NASA/DOD EARTH ORBIT SHUTTLE TRAFFIC MODELS BASED ON END-TO-END LOADING OF PAYLOADS

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NASA/DOD EARTH ORBIT SHUTTLE TRAFFIC MODELS

BASED ON END-TO-END LOADING OF PAYLOADS

By Richard Kincade, Michael Donahoo, and William Pruett

1.0 SUMMARY

This report is the first of two documents written to present optimized Earth Orbit Shuttle traffic models for the years 1979 through 1990 and will partially fulfill the requirements of reference 1 for NASA/DOD traffic model and fleet sizing analyses. The traffic models contained herein satisfy the requirements that two separate cases be analyzed--first, a DOD or foreign developed resuable tug will be available in 1979; and second, expendable boosters will be used through the year 1984 with a NASA developed resuable tug available in 1985. The tug characteristics are the same for either case. Both traffic model cases consider only end-to-end stacking of the satellites on the tug. A second traffic model will be defined in another internal note with the major difference between the two documents being the change in the mode of cargo loading. For the later analysis all cargo will be loaded side-by-side.

The reason for analyzing the two different methods of loading is that although the groundrules of reference 1 state that the number of payloads on any one Earth Orbit Shuttle mission should not exceed three and that these payloads may be stacked either end-to-end or side-by-side, they do not specify what loading method should be used in defining the traffic models.

Previous analyses have indicated that because the satellites are usually deployed separately with a phasing maneuver between deployments, side-by-side loadings are apt to present more problems than end-to-end stacking. Very little is known about what c.g. limits the tug will have, what the tug's gimbal limits will be for alining the thrust through the c.g., the amount of loading the tug structure can withstand and what affect these factors will have on tug loadings. Another factor which could preclude side-by-side loading is an increase in the diameters of the satellites. These increases may occur in the future and will probably affect the majority of the payloads.

Although the above reasons for end-to-end loading of payloads on the tug appear to be valid, side-by-side stacking should not be completely eliminated from any future planning. Side-by-side loadings could save a number of EOS flights and, therefore, reduce the cost of the program significantly. It is not intended that either of the two documents recommend one loading method over the other. Each of the two loading methods are analyzed using the same groundrules with the reader free to determine which mode of cargo loading should be used in future planning.

2.0 INTRODUCTION

To obtain the most economical usage of the EOS, it is imperative that the maximum number of missions should be accomplished with the minimum number of EOS flights. A number of traffic models and fleet sizing studies are anticipated prior to actual mission planning for the EOS program. The purpose of this report is to present optimized EOS traffic models associated with two possible reusable tug availability dates and end-to-end loading of satellites on the tug or booster using the NASA and DOD payload information obtained from OSSA, Space Station, and DOD mission models generated specifically for this purpose.

At the time this traffic model was being defined the DOD was updating their mission models; therefore, this report does not reflect the official DOD program. However, the DOD missions used in this report and contained in reference 2 are considered to be representative.

3.0 SYMBOLS AND ABBREVIATIONS

ABES	Air Breathing Engine Subsystem
DOD	Department of Defense
EOS	Earth Orbit Shuttle
fps	feet per second
ha .	height of apogee
h p	height of perigee
NASA	National Aeronautics and Space Administration
n. mi.	nautical miles

OMS

Orbital Maneuvering System

OSSA

Office of Space Science and Applications

ΔV

change in velocity

4.0 GROUND RULES

The missions of the traffic models were combined into EOS payloads according to the groundrules defined in reference 1 and listed below:

- a. NASA and DOD missions shall be flown separately.
- b. The maximum number of payloads carried on a single mission should not exceed three.
- c. The payloads should be integrated into the EOS cargo compartment either end-to-end or side-by-side. Payloads should not be stacked atop each other.
- d. Each mission needing an energy stage for payload placement requires a dedicated EOS flight.
- e. The EOS capability to be used is presented in figure 1. The preferred mode of operation is with ABES on and OMS propellant equivalent to 1500 fps in the tanks. Those missions on which OMS or ABES must be offloaded to gain necessary capability should be identified.
- f. The first 10 EOS flights are not to be analyzed. These flights will be identified in detail by the NASA Headquarters.
- g. Starting with NASA flight number 5 and DOD flight number 3 in 1979, the choice of payloads is to be based on the NASA priorities defined in table I. The DOD missions are to be selected from reference 2, with the mission at the bottom of the table having the highest priority and the mission at the top of the page (first part of the alphabet) having the lowest priority.
- h. It should be assumed that the EOS has the capability to fly all payloads starting in 1982.

5.0 DISCUSSION

The EOS, as it is presently designed, has the capability (figure 1 defines payload weight as a function of inclination) to accomplish, without the assistance of a boost stage, a little more than half of the NASA flights planned for the period from 1978 through 1990 with these flights encompassing Space Station, sortie, automated spacecraft, man-tended spacecraft and non-NASA (excluding DOD) missions. Based on the DOD information supplied for this study, approximately 40 percent of the DOD flights are assumed to require booster or tug assistance.

In previous traffic models, kick stages such as the Centaur, Agena and FW-4S or a reusable tug have been used for satellite placement when the EOS did not have the capability. These studies have assumed that the tug could take 10 000 pounds to an equatorial geosynchronous orbit from the basic EOS 100 n. mi. circular orbit inclined 28.5° and then return empty to the EOS. The request made in reference 1 specifies that all traffic models shall be designed using a tug with half this capability (the capability curves for this tug are presented in figure 2) and that boosters shall be employed for those years in which the tug is not available.

Another difference between the traffic models for this report and others derived in the past will be found in the methods used in determining the total payload weight. Other traffic models assumed the tug carried a full load of fuel for every mission in order to insure that there would be enough propellant for any required phasing and terminal rendezvous maneuver. Minimum fuel usage computations assume that transfers from one orbit to another are the only maneuvers that are required.

Although neither maximum nor minimum fuel consumption presents a truly accurate account of the number of EOS flights required, minimum fuel loadings would be more nearly correct because it is not envisioned that large amounts of propellant will be needed for phasing and rendezvous maneuvers. Therefore, minimum fuel usage is assumed in this study for all tug flights.

The above tug data plus the groundrules presented in section 4.0 constitute the basis for the two traffic model studies described in this report. For both models, every attempt is made to combine payloads with similar inclination and destination characteristics. Lengths, diameters and weights of the cargo are also prime factors in the combination process (the cargo bay dimensions are 15 X 60 feet while the maximum payload which can be carried to the low earth parking orbit varies according to the inclination of the orbit). Combination of two identical satellites is not done unless specifically called for in the mission models of reference 1 or, if necessary, to keep the EOS flights at a minimum. At no

time is a combination of a NASA and DOD payload allowed. Very little is known about either NASA or DOD packaging and mounting factors; and therefore, these items are not considered in the end-to-end stacking combinations. In the years when the tug is available, booster stages are used only when the tug does not have the capability to place the payload in orbit.

The number of EOS flights planned for the years 1978 through 1981 (table II) limits the number of missions which can be performed by the EOS during this period. The first 10 flights, 4 in 1978 and 6 in 1979, are to be defined in detail by NASA Headquarters and are not included in the traffic models but are shown in some of the tables presenting total EOS flights.

Because the number of EOS flights required for the 1978 through 1981 period greatly exceeds the maximum number of flights planned, the OSSA priorities listed in table I are used as the basis for NASA payload selection. The highest priority for DOD missions starts at the bottom of the DOD payload characteristics and frequencies table of reference 2 and works up the table with the mission listed at the top having the lowest priority. If all DOD missions could not be accommodated on the limited number of flights, an attempt is made to include at least one of each type.

After the year 1981, no restrictions are placed on the number of EOS flights, thus an unlimited traffic model exists for the period from 1981 through 1990. The frequencies and payload characteristics of the DOD and NASA mission models are presented in reference 2 and table III, respectively.

The amount of propellant used determines the tug life. In this study, the tug is considered to be expended after 500 000 pounds of propellant have been consumed by the tug engines. As mentioned previously, minimum tug fuel consumption is assumed for each flight of these traffic models. Actual fuel usage considering all station-keeping, phasing, transfer and other rendezvous and docking maneuvers will increase the fuel usage but is impossible to calculate at the present time since the missions are so ill defined. The addition of the tug fuel necessary to perform these maneuvers should not increase the number of tugs expended significantly. The boosters are flown with the fuel tanks full in order to keep computation time to a minimum.

For sun synchronous payload placements by the tug, the EOS is placed in a 90° inclination orbit and the tug makes the plane changes. If the EOS were to take the payload to the sun synchronous orbit inclination then the amount of OMS propellant that has to be offloaded would exceed the amount of tug propellant consumed, thus reducing the efficiency of the EOS. The EOS makes the plane changes for FW-4S payload placement because the FW-4S is so light.

The characteristics of the reusable tug along with those for the various non-reusable booster stages are presented in table IV. The tug data was extracted from reference 1 while booster information was obtained from reference 3. Figure 2 defines the tug payload capability as a function of ΔV .

The actual combination of payloads, both NASA and DOD, for end-to-end loadings are defined in tables V and VI for the tug availability dates of 1979 and 1985, respectively. It should be noted that the EOS flights of these tables would not necessarily be flown in the order presented. Expediency in selecting the payloads and simplicity of the methods used in the analysis dictated the order in which the flights are presented in these tables.

Tables V and VI are further reduced to the number of EOS flights and the total number of payloads associated with these flights (table VII). The number of EOS flights by inclination (table VIII), the total payload taken to orbit (table IX), the energy stages required (table X), and the number of EOS flights per year (table XI) are tabulated for information.

The traffic models indicate that when the tug will be in service starting in 1979, 811 missions are accomplished on 670 EOS flights. Of these 670 flights, 452 carry NASA payloads (564 missions) while 218 carry DOD payloads (247 missions). Combinations of NASA and DOD payloads are not permitted, and therefore, are not attempted. One hundred and ninety-four of the 452 NASA flights and 98 of the 218 DOD flights require tugs.

The traffic model for the second tug availability date of 1985 consists of 642 EOS flights (832 missions), and these flights are relegated to 430 flights for the 578 NASA missions and 212 flights for the 254 DOD missions. Tugs are used on 110 of the NASA flights and 53 of the DOD flights. The first 10 EOS flights are not included in any of the above numbers.

The first traffic model requires the expenditure of 12 tugs for NASA missions (table X). Eleven of these 12 are expended because the tug does not have the ΔV capability to return to the EOS after satellite placement. However, this is not as big a waste of tugs as it might first appear because if the tugs that are expended in the traffic model could return to the EOS, 11 tugs would still have to be retired based on 500 000 pounds of fuel consumption constituting the retirement of a tug. DOD missions result in the expenditure of six tugs, all resulting from 500 000 pounds propellant usage. Totalling the two organizations tug expenditures together, 18 tugs are expended.

When the tug is not used until 1985, ll tugs are required to be expended with NASA and DOD missions accounting for eight and three tugs, respectively. All eight of the tugs expended for the NASA flights are

attributed to the tug not having the capability for a round trip (six tugs would be retired by the fuel usage requirement even if all eight of the tugs could be returned). All DOD tug expenditures result from normal tug retirement.

In the event the weight of the tug plus satellites exceeds the nominal designed payload capabilities of the EOS, either OMS propellant is offloaded or the ABES is removed in order to gain the necessary capabilities. In this study, it is assumed that OMS propellant offloading (maximum offloaded is equivalent to a ΔV of 600 fps at an inclination of 28.5° and 500 fps at an inclination of 90°) will be considered first and the ABES will be removed only if the EOS cannot perform orbit insertion after OMS propellant reduction.

For the first traffic model, 165 flights (132 NASA and 33 DOD) require offloading of OMS and 13 flights (7 NASA and 6 DOD) cannot be performed without the removal of the ABES. If the tug does not become available until 1985, the total number of flights requiring either offloading of OMS or removal of ABES drops to 91 and 22 for NASA and DOD, respectively. No flights required both the removal of the ABES and the offloading of OMS. Table XII further identifies those flights requiring the removal of the ABES or offloading of the OMS propellant.

6.0 COMMENTS

When the tug is available in 1979 approximately 30 percent of the EOS flights carrying NASA cargo require either offloading of OMS propellant or the removal of the ABES to accomplish the flight. percentage for DOD flights is approximately 18 percent. For the 1985 availability date, the percentages drop to roughly 20 percent and 10 percent for NASA and DOD, respectively. The reason for these offloadings is that large amounts of tug propellant are necessary to place the satellites in orbit. This is especially true for equatorial geosynchronous orbits where 40 000 to 49 000 pounds of propellant are required for a round trip and the maximum weight the EOS can take to the 100 n. mi. circular orbit at a 28.5° inclination without OMS fuel reduction or ABES removal is 50 000 pounds. Although not nearly as much propellant is required for a polar or sun synchronous orbit, the situation is just as bad for these high inclination orbits since the inert weight of the tug is approximately one half of the payload capability of the EOS with the ABES on and full OMS ΔV fuel loading.

There is probably no way the tug characteristics can be changed such that less fuel is needed for the equatorial geosynchronous orbits. However, it does seem feasible to use some small solid stages such as

the FW-4S for satellite placements in polar and sun synchronous orbits since it was found that the size of the tug was the reason that two EOS flights were often needed to complete these missions. The use of these small solid stages should save approximately 10 flights over the 12-year period and would eliminate the necessity for offloading of OMS propellant or the removal of the ABES for the polar and sun synchronous orbit missions.

Overall, this analysis has attempted to take the groundrules of reference 1 and define the most optimum traffic models for the two tug availability dates and end-to-end stacking of the NASA and DOD payloads. A similar report containing side-by-side loadings is forthcoming shortly. No recommendations are made as to which method of payload integration on the tug should be planned for in the future. The decision on which mode of cargo loading will be used is left to NASA management.

TABLE I.- OSSA PRIORITY ASSIGNMENT

		\neg						_				
	Total		6		. 91		17		9	5	511	122
III	81									τ	18	19
Priority	80			•							12	12
Pri	79	`								3	15	18
H	81						7 4					, 16
Priority	80	3					4 3 6			1		1,4
Pr	79	<u>`</u>					6 1 5					ટા
Н	81	1	6		25				1 2			20
Priority I	80).			9				2			8
Pri	79	<u> </u>			2		•		7			κ ·
	Mission		Space station	Sortie	Type 1 Type 2 Pallet	Automated S/C	Comm/nav Earth obs. Physics/astr.	Man tended	LST HEAO revis.	Planetary	Non-NASA	TOTAL

TABLE II.- MAXIMUM NUMBER OF EOS FLIGHTS WHICH

CAN BE FLOWN FOR THE PERIOD 1978-81

	^a 1978	^b 1979	1980	1981
NASA	. 3	10	24	34
^ DOD	1	14	12	· 16

aThe flights for the year 1978 will be defined by NASA headquarters.

Four of the NASA flights and two of the DOD flights will be defined by NASA headquarters for the year 1979.

TABLE III.- NASA AND NON-NASA (EXCLUDING DOD) PAYLOAD CHARACTERISTICS AND FREQUENCIES

(a) Physics and astronomy

		Р	ayload characteri	istics	Fi	nal orbital paramete	ers							Year	05	86	87	88	89	90
Payload designation	Satellite name	Diam.	Lgth.	Wt.	i	h _a	h _p	78	79	80	81	82	83	84	85	2	1	2	2	
1 2 3 4	Astronomy explorer Radio explorer Low magnetosphere explorer Middle magnetosphere explorer High magnetosphere explorer	2 5 4 6	3 4 8 8	720 720 1 200 1 000 600	28.5 28.5 0-90 0-90	270 19 300 1 800 20 000	270 19 300 180 1 000 Any	1 1 (90) 1 (90) 1 (90)	1 (0) 1 (0) 1 (0)	1(28.5) 1(28.5) 1(28.5)	1 1 1(55) 1(55) 1(55)	1(90) 1(90) 1(90)	1(0) 1(0) 1(0)	1 1(28.5) 1(28.5) 1(28.5)	2 1(55) 1(55) 1(55)	1(90) 1(90) 1(90)	1 1(0) 1(0) 1(0)	1(28.5) 1(28.5) 1(28.5)	1(55) 1(55) 1(55)	1(90) 1(90) 1(90)
6 7	Orbiting solar observatory Gravity/relativity experiment (C, E)	7 5	10 7	1 900 1 500 500	28.5 90 28.5	350 300 1.0 A.U.	300 300 1.0 A.U.				1 ^B			1			10			:
.8	Gravity/relativity experiment (B, D) Radio interferometer	12	15	6 000	28.5	38 300	38 300				1			,					1	
10 11 12 13	synchronous Solar orbit pair synchronous Solar orbit pair 1 A.U. Optical interferometer pair High energy stellar astronomy observatory (HESAO)	10 10 7 ea 14	12 12 10 ea 46	1 900 1 900 3 500 ea 21 000	30 28.5 30 30	19 300 1.0 A.U. 19 300 230	19 300 1.0 A.U. 19 300 230		1(up)	2	2 1(up)	1(up) 2	l(down) 2	2	1(up) 2 1(down)	2	1(down) 2	2	1 1(up) 2	;
14 15 16 17	HESAO revisit Large space telescope (LST-RAM) LST-RAM revisit Large solar observatory (LSO)	14 14 14	13 60 13 54 13	30 000 3500 27 000 3 500	28.5 30 30 30	350 350 350 350	350 350 350 350		-		1 (up)	2	2 1(up)	2 2	1(up) 1 2 1(up)	2 2	2 2	2 1(d), 1(w) 1	2 2 2	
18 19	LSO revisits Large radio observatory (LRO) LRO revisits	14 14 14	30 13	19 300 3 500	30 30	350 350	350 350			<u> </u>		<u> </u>			<u></u>	<u></u>		<u></u>	<u></u>	

(b) Earth observations (R and D)

Payload			Payload characte	ristics	F	inal orbital paramet	ters							Year						
designation	Satellite name	Diam. ft.	Lgth. ft.	Wt.	i	h _a	h _p	78	79	80	81	82	83	84	85	86	87	88	89	90
21	Polar earth observation satellite	, 6	12	2 500	99.15	500	500		1	1	1	1	1	1	1	1	1	1	1	1
22	Sync. earth observation satellite	4	6	1 000	0	19 300	19 300			1		1		1		1	i i	1		1
23	Earth physics satellite	3.5	6.5	600	90	400	400			1	1	1	1		_1		1		1	_
	Systems demonstrations																			
24	Sync. meteorological satellite	5	8	1 000	0	19 300	19 300					1	1							
25 26	Tiros Polar earth resources satellite (take two at a time)	5 6	10 12	1 000 2 500	101.1 99.15	700 500	700 500		,		1				1	2	4			1
27	Synchronous earth resources satellite	4	6	1 000	0	19 300	19 300				1	2	1				1	- 2		

TABLE III. - NASA AND NON-NASA (EXCLUDING DOD) PAYLOAD CHARACTERISTICS AND FREQUENCIES - Continued

(c) Communications and navigation (R and D)

Payload			Payload character	ristics	F	inal orbital paramet	ers							Year						
designation	Satellite name	Diam. ft.	Lgth. ft.	Wt. Ib.	i	h a	hp	78	79	80	81	82	83	84	85	86	87	-88	89	90
28	Applications technology satellite	15	20	7 950	0	19 300	19 300		1		1		1	1		1		1	1	
29	Small app. technology satellite synchronous	6.5	12	600	0	19 300	19 300	1	1	1	1	1	1	1	1	1	1	1	1	1
30	Small app. technology satellite polar	6.5	12	600	90	3 000	300	1	1	1	1	1	1	1	1	1	1	1	1	1
31	Cooperative application synchronous	6.5	12	820	0	19 300	19 300		1					1			•			
32	Cooperative application polar	6.5	12	820	90	3 000	300		-			. 1							1	
								S	ystems demonst	ration						•				
33 34 35	Medical network satellite Education broadcast satellite Follow-on system demonstration	12 10 12	15 19 15	2 000 2 145 2 000	0 0 0	19 300 19 300 19 300	19 300 19 300 19 300		2	2	2	2	2	2	2	2	2	2	2	2
									Operation	al										
36 37	Tracking and data relay Planetary relay satellite	12 10	15 20	2 300 1 000	0	19 300 19 300	19 300 19 300		1 2	2 1	1		2	. 1	2		2	1	1	2

(d) RAM sortie missions

		F	ayload character	istics	F	inal orbital paramet	ers							Year						
Payload designation	Satellite name	Diam. ft.	Lgth. ft.	Wt. lb.	i	h _a	h _p	78	79	80	81	82	83	84	85	86	87	88	89	90
38	General scientific research module sortie	14	54	27 500	55	200	200				2	3	4	4	3					
39	General applications module sortie	14	51	30 000	65	100	100				2	3	2	3	2	3		3	1	
40	Dedicated scientific research module-astronomy sortie	14	54	29 500	55	200	200				i			1	3	4	5	4	5	5
41	Dedicated applications module- earth observation sortie	14	41	22 500	75	100	100							2	2	2	2	2	3	4
									Pallet-type mo	odule		-								,
42 43 44 45 46 47 48	Earth resources sortie Bio research module sortie Astronomy sortie Fluid management sortie Teleoperator sortie Manned work platform sortie Large telescope mirror test sortie	14 14 14 14 14 14	37 37 37 37 37 37 37	6 000 4 300 5 700 7 100 5 000 6 700 13 000	90 28.5 28.5 28.5 28.5 28.5 28.5	125 200 200 200 200 200 200 200	125 200 200 200 200 200 200 200		1	1 2 1 1	1 2 1	2	1 1							
49	Astronomical maneuvering unit sortie	14	37	3 800	28.5	200	200			1		,								

TABLE III. - NASA AND NON-NASA (EXCLUDING DOD) PAYLOAD CHARACTERISTICS AND FREQUENCIES - Concluded

(e) Planetary

			Payload character	ristics	F	inal orbital parameters		····			,	_	Year						
Payload designation	Satellite name	Diam. ft.	Lgth.	Wt.	i	ΔV required, fps	. 78	79	80	81	82	83	84	85	86	87	88	89	90
50 51 52 53 54 55 56 57 58	Mars Viking Mars sample return Venus explorer Venus radar mapping Venus explorer lander Jupiter pioneer orbiter JUN grand tour Jupiter tops orbiter/probe Uranus tops orbiter/probe Asteroid survey Comet rendezvous	10 15 5 10 10 10 10 10 10	12 22.5 12 12 15 15 15 12 15 15	7 700 22 000 1 000 7 900 7 300 900 1 500 3 300 3 700 27 000 24 000	30 30 30 30 30 30 30 30 30 30	15 400 15 400 13 400 13 400 13 400 22 700 25 900 22 700 24 000 13 400 13 400		2	1	1	2		1	1 1	1	1	1	1	2

(f) Space station

Douberd		F	ayload character	ristics		Final orbital paramet	ers	<u> </u>						Year						
Payload designation	Satellite name	Diam. ft.	Lgth. ft.	Wt.	i	ha	hp	78	79	80	81	82 ,	83	84	85	86	87	88	89	90
61	Station module-core (includes refurbishment)	14	40	20 000	55	270	270				1	1		1	1	3	2			
62	Station module-others	14	30	20 000	55	270	270	1	1		5		1		3			l		
63	Crew/cargo	14	30	20 000	55	270	270			1	1	6	6	6	6	. 8	8	1 8	8	8
64	Physics laboratory	14	32	22 000	55	100	270			1			1(up)			1(down)		1(up)		
65	Cosmic ray laboratory Part I	14	52	30 000	55	270	270			1								1(up)		
	Cosmic ray laboratory Part II	14	7	24 000	55	270	270	1	1	1		1		1	İ			1(up)	1	
66	Life sciences lab	14	58	33 000	55	100	270	1	1		1(up)	1	1(down)		1(up)					1(down)
67	Earth observation laboratory	14	45	25 000	55	100	270	1		}	1(up)		1(down)	<u> </u>	1(up)			i	1	1(down)
68	Communications/navigation laboratory	14	38	19 000	55	100	270	l .					1(up)		1(down)					1(up)
69	Space manufacture laboratory	14	45	25 000	55	100	270											,		1(up)

(g) Non NASA

Payload		Р	ayload character	istics	Fi	nal orbital paramete	rs					:		Year					-	<u>_</u>
designation	Satellite name	Diam. ft.	Lgth. ft.	Wt. lb.	i	h _a	hp	78	79	80	81	82	83	84	85	86	87	88	89	90
70 71 72 73 74 75 76 77	Comsat satellite U. S. domestic communication Foreign domestic communication Navigation and traffic control Tos meteorological Synchronous meteorological Polar earth resources (take two at a time) Synchronous earth resources	6.5 10 4 5 5 5 12	12 19 12 8 8 6 8 15	1 420 2 145 1 000 700 700 1 000 1 000 2 500	0 0 0 29 5 101.1 0 99.15	19 300 19 300 19 300 30 000 19 300 700 19 300 500	19 300 19 300 19 300 16 000 19 300 700 19 300 500	2 2 2 1 1 1 1	2 1 3 1 1 4	1 2 2 1 1 1	1 6 2 1 1 1	1 2 1 1	2 2 1 1 1 - 1 4	1 1	1 2 1 1 1 4	2 4 1	. 2 5 1 1 1	2 2 2 1 1	1 2 1 1 1 1 6	2 2 1 1

TABLE IV.- CHARACTERISTICS OF THE REUSABLE
TUG, CENTAUR, AGENA, AND FW-4S

	Tug	Centaur	Agena	FW-4S
Dry weight, lb	6 818	4 614	1 380	90
Maximum propellant loading, lb	49 550	29 ·858	13 440	608
I sp, sec	460	442	310	283
Dimensions, ft	14.5 × 40	10 × 30	5 × 20	2 × 5

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979

	-		(a)	(a) NASA - 1979	79				
Shuttle	Payload	Total payload	Total payload		Original EOS orbit	್ ಫ	Satellite final orbit	Total	Round trip minimum tug
	10110II	(D × L)	weight, lb ^B	1, deg	ha/hp, n. mi.	i, deg	ha/hp, n. mi.	ΔV required	propellant required, lb
н	Bio research module sortie plus astronomy explorer	0η × ητ	5 020	28.5 28.5	200/200 270/270	Same	Same as EOS orbit		
N	Large telescope mirror test sortie plus astronomy explorer	07 × 71	13 720	28.5 28.5	200/200 270/270	Запе	Same as EOS orbit		
en .	High energy stellar astronomy observatory (HESAO) placement	97 × 71	21 000	30.0	230/230	Звие	Same as EOS orbit		
a	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	b ₅₃ 555	28.5	100/100	00	1 800/180 20 000/1000	28 755	585 th
٧.	Small applications tech- nology synchronous plus high magnetosphere explorer	14.5 × 58	⁶ 52 170	28.5	100/100	00,	19 300/19 300 1 A.U./19 300	28 865	150 pt
, 9	Medical network	14.5 × 55	^b 51 315	28.5	100/100	. 0	19 300/19 300	28 190	42 495

abased on the minimum propellant required to place payloads in orbit.

boms must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

	<u></u>	,		_
	Tug propellant required, lb			
•	Payload weight, lb		-	
(a) DOD - 1979	Payload dimensions, ft (D × L)			
	Payload description	None	None	
	Shuttle flight no.	ei	2	

 $^{\mathrm{a}}\mathrm{Payloads}$ are defined in classified addendum (ref. 2).

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(b) MASA - 1980

Round trip minimum tug	propellant required, lb		<u> </u>		-			43 350	5 060	42 530	13 160	41 150	9 200	42 495	41 350 ·
Total	ΔV required							28 725	7 840	28 190	28 190	28 190	11 255	28 190	. 27 965
Satellite final orbit	h, h, n. mi.	as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	Same as ROS orbit	19 300/19 300 19 300/19 300	3 000/300	19 300/19 300	19 300/19 300	19 300/19 300	500/500 700/700	19 300/19 300	350/350 19 300/19 3 <u>00</u> 1 A.U./19 300
3 4	1, deg	Same	Same	Seme	Seume	Same	Seme	50	88	0	0,	0	99.15	0	28.5 28.5 28.5
Original EOS orbit	ha/hp, n. mi.	125/125	200/200	200/200	200/200	200/200	230/230	100/100	100/100	100/100	100/100	100/100	100/100	100/100	001/001
o M	1, deg	90.0	28.5	28.5	28.5	28.5	30.0	28.5	90.0	28.5	28.5	28.5	90.0	28.5	28.5
Total	weight, 1ba	9.000	.5 700	7 100	2 000	3 800	3 500	⁶ 51 470	^b 13 080	ρ ⁵ 1 495	^b 53 280	η 970	^b 19 320	^b 51 315	^b 51 390
	dimensions, ft (D × L)	1ξ × 41	14 × 37	14 × 37	14 × 37	14 × 37	14 × 13	14.5 × 60	14.5 × 58	14.5 × 59	14.5 × 55	14.5 × 60	14.5×58	14.5 × 54	14.5 × 60
Payload	description	Earth resources sortie	Astronomy sortie	Fluid management sortie	Tele operator sortie	Astronomical maneuvering unit sortie	HESAO revisit	Small applications technical-synchronous plus navigation and traffic control	Small applications tech- nology - polar plus earth physics	Education broadcast	Tracking and data relay	Planetary relay	Polar earth observation plus TOS meteorological	Synchronous earth observa- tion plus synchronous meteorological	Orbiting solar observatory plus radio explorer plus high magnetosphere explorer
Shuttle	rlight no.	τ	2,3	4	٠ ٠	v 9	7,8	6.	01	11,12	13,14	15	16	17	18

^aBased on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 m. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(b) NASA - 1980 - Concluded

dimensions, ft	Total		Original EOS orbit	″ ដ	Satellite final orbit	Total	Round trip minimum tug	
(D × L)	weight, 1b	i, deg	i, deg ha/h, n. mi. 1, deg ha/h, n. mi.	1, deg	h, h, n. mi.	AV required	propellant required, lb	
orer 14.5 × 60 plus	46 215	28.5	001/001	28.5 28.5 28.5	1 800/180 19 300/19 300 20 000/1000	25 985	36 475	
14.5 × 52	0ሳይ ካሳ	30.0	100/100	- н	Planetary	26 800	36 520	
14.5 × 52	572 67q	28.5	100/100	0	19 300/19 300	28 190	41 505	
U.S. domestic communication 14.5×59	P ₅₁ 495	28.5	100/100	0	19 300/19 300	28 190	հ2 530	
Foreign domestic communication	հ1 885	28.5	001/001	28.5	19 300/19 300	25 835	34 065	
0 4 1		14.5 × 59 14.5 × 59	14.5 × 59	14.5 × 59	14.5 × 59 ^b 51 495 28.5 100/100 14.5 × 59 41 885 28.5 100/100	14.5 x 59 b ₅₁ 495 28.5 100/100 0 14.5 x 59 41 885 28.5 100/100 28.5	14.5 × 59 ^b 51 495 28.5 100/100 0 19 300/19 300 14.5 × 59 41 885 28.5 100/100 28.5 19 300/19 300	14.5 x 59 b51 495 28.5 100/100 0 19 300/19 300 28 190

 $^{\mathbf{a}}$ Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(ъ) DOD - 1980

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-5	None		·	
6-7	N-2B	5 × 15	1 400	38 364
8	N-2A	5 × 15	1 400	29 360
9	Three M-1	5 × 3 (each)	700 (each)	^b 7 481
10	S-4	9 × 60	10 000	
11	S-2B	15 × 25	5 000	18 756
12	C-1 C-3A	9 × 8 6 × 7	1 100 700	^b 42 362

^aPayloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAXIOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979

(c) NASA - 1981

Shuttle flight no.	Payload	Total payload dimensions, ft	Total payload a	ОП	Original EOS orbit	8 £1	Satellite final orbit	Total	Round trip minimum tug
,			weight, lb	1, deg	ha/hp, n. mi.	i, deg	ha/hp, n. mi.	AV required	propellant required, lb
7	Station module - core	01 × 11	20 000	55	270/270	Same	as EOS orbit		
5-6	Station module - others	14 × 30	20 000	55	270/270	Same	as EOS orbit		
7	Station crew/cargo	14 × 30	20 000	55	270/270	Seme	as EOS orbit		
80	Life Sciences Lab (up)	14 × 58	33 000	55	100/270	Same	as EOS orbit		
6	Earth Observation Lab (up)	14 × 45	25 000	55	100/270	Same	as EOS orbit		
10-11	General actentific research module sortie	14 × 54	27 500	55	200/200	Same	as EOS orbit		
12-13	General applications module sortie	14 × 51	30 000	59	100/100	Sene	as EOS orbit		
14	Earth resources sortie	14 × 43.5	009 9	8	125/125	Sвше _	as EOS orbit		
15-16	HESAO revisit plus astronomy sortie	14 × 50	9 200	30	230/230 200/200	Same	as EOS orbit		
11	Manned work platform sortie plus astronomy explorer	34 × 40	7 420	28.5 28.5	200/200 270/270	Same	as EOS orbit		
18	Large space telescope (LST)	14 × 60	30 000	28.5	350/350	Same	as EOS orbit		
19	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	^b 23 535
50	Navigation and traffic control plus small applications technical satellite - synchronous	14.5 × 60	027 750	28.5	100/100	50	19 300/19 300 19 300/19 300	28 725	43 350
12	Small application tech- nical - polar plus earth physics	14.5 × 58	°13.080	06	100/100	88	3000/300	7 840	90 5
22-23	Follow-on systems demonstration	14.5 × 55	°51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
7₹	Tracking and data relay	14.5 × 55	°52 285	28.5	100/100	0	19 300/19 300	28 190	43 165
25	Polar earth observation plus Tiros	14.5 × 58	°19 320	8	100/100	99.15	500/500	n 255	9 200
•									

 $^{\mathbf{a}}_{\mathbf{b}}$ based on the minimum propellant required to place payloads in orbit.

COMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit. brhe tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	Round trip minimum tug	required, 1b	8 175	5617 717	36 495	. 16 470	22 500	045 L4	26 760	η3 360	37 055
	Total	required	11 120	28 190	26 500	17 390	21 180	27 640	15 400	28 190	26 500
	Satellite final orbit	ha/h, n. mi.	700/700	19 300/19 300	19 300/19 300 30 000/16 000	1800/180 20 000/1000	1 A.U./1000	38 300/38 300 1 A.u./38 300	Planetary	19 300/19 300	19 300/19 300 30 000/16 000
	S . fi	1, deg	101	0	28.5	55 55	55	28.5 28.5	<u>-</u> д, -	0	28.5 29
ncluded	Original EOS orbit	ha/h, n. mi.	100/100	100/100	100/100	100/100	001/001	100/100	001/001	100/100	100/100
1981 - Co		i, deg	96	28.5	28.5	. 55	55	28.5	30	28.5	28.5
(c) NASA - 1981 - Concluded	Total payload	veight, lb ^a	366 51	^b 51 315	1557 44	25 490	29 920	098 094	η0 280	⁵ 2 600	35 020
•	Total payload	(D × L)	14.5 × 50	14.5 × 58	14.5 × 52	14.5 × 56	14.5 × 46	14.5 × 60	14.5 × 52	14.5 × 60	14.5 × 60
	Payload	description	Tiros	Synchronous earth resources plus foreign domestic communication	Medical network satellite plus navigation and traffic control	Lover magnetosphere explorer plus middle magnetosphere explorer	High magnetosphere explorer	Radio interferometer synchronous plus gravity relativity experiment B	Mars Viking	Comsat plus synchronous meteorological	Foreign domestic communica- tion plus navigation and traffic control
	Shuttle	tight no.	56	27	. 58	58	8	я 	32	33	φ.

Abased on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(c) DOD - 1981

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			,
11	C-3B	6 × 7	700	^b 21 450
12	C-4	9 × 20	2 300	16 450
13-14	S-2A	15 × 25	5 000	^c 47 461
15	S-4	9 × 60	10 000	
16.	Three M-1	5 × 3 (each)	700 (each)	^c 7 481

^aPayloads are defined in classified addendum (ref. 2).

bABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

^cOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

			(a)	NASA	1982				
Shuttle	Payload	Total payload	Total payload	OT.	Original EOS orbit	Se f1r	Satellite final orbit	Total tug	Round trip minimum tug
ilight no.	description	dimensions, ft (D × L)	weight, lb ⁸	i, deg	ha/hp, n. mi.	1, deg	h _a /h _p , n. mi.	ΔV required	propellant required, 1b
1-2	Astronomy explorer plus follow-on systems demonstration	14.5 × 58	^b 52 035	28.5	100/100	28.5 0	270/270 19 300/19 300	28 190	42 495
e	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	°25 490	90.0	100/100	8 8	1800/180 20 000/1000	17 390	16 470
	Polar earth observation	14.5 × 52	₀ 80 91 _q	90.0	100/100	99.15	200/200	060 6	. 6 760
٤,	High energy stellar astronomy laboratory (up) plus	14 × 59	24 500	28.5	350/350	28.5 30	350/350 230/230		
2-9	HESAO revisit plus astrono- my sortie	14 × 50	9 200	30	230/230	30 28.5	230/230		
80	LST revisit	14 × 13	3 500	28.5	350/350	Bame	as EOS orbit		
6	Synchronous earth observation synchronous meteorological plus synchronous earth resources	14.5 × 60	₉ ς ₄ 085	28.5	100/100	0	19 300/19 300	28 190	th 265
10	Earth physics plus small applications technical-polar	14.5 × 58.5	^b 13 080	06	100/100	88	3000/400 3000/400	7 840	2 060
ជ	Synchronous earth resources plus small applications tech synchronous	14.5 × 58	ο ₁ 9 970	28.5	100/100	0	19 300/19 300	28 190	41 550
12	Cooperative application polar plus TOS meteorological	14.5 × 58	°21 895	8	100/100	90 1.101	3000/300 700/700	14 995	13 255
13-15	General scientific research module sortie	14 × 54	27 500	. 55	200/200	заше	as EOS orbit		
16-18	General applications module sortie	14 × 51	30 000	9	100/100	s ame	as EOS orbit		
19-20	Earth resources sortie	14 × 37	6 000	90	125/125	Same	as EOS orbit		

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

CABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(d) NASA - 1982 - Concluded

Payload	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb	i, deg	Original EOS orbit ha/hp, n. mi.	S. fi.	Satellite final orbit i, deg ha/hp, n. mi.	Total tug AV required	Round trip minimum tug propellant required, lb
· 11 × 30	. × 7.T	30	50 000	55	270/270	Заше	Same as EOS orbit	ł	ı
Venus radar mapping 14.5 x 52	14.5 × 9	25	₀ ≥0 240	30	100/100	- p	Planetary	26 800	545 94
Jupiter pioneer orbiter 14.5×55	14.5 × 9	25	36 090	30	100/100	_P	Planetary	22 700	28 370
Comet rendezvous payload 10 x 35	10 × 3	5	54 000	30	100/100	Same	Same as EOS orbit	ł	1
Tug for comet rendezvous 14.5 x 40	14.5 × 4(^b 52 310	30	100/100	<u> </u>	Planetary	13 400	0617 517
U.S. domestic communica- l^{4} ,5 x 59 tions	14.5 × 59		_δ ς1 495	28.5	100/100	0	19 300/19 300	28 190	42 530
Foreign domestic com- 14.5 x 52 munication	14.5 × 5	N.	41 885	28.5	100/100	28.5	008 61/008 61	25 835	34 065
Foreign domestic communication plus synchronous meteorological	14.5 × 6	.0	^b 51 315	28.5	100/100	0	19 300/19 300	28 190	56t St
High magnetosphere ex- 14.5×46 plorer	14.5 ×	91	026 62	8	100/100	06	1 A.U./1000	21 180	22 500

 $^{\mathbf{a}}$ Based on the minimum propellant required to place payloads in orbit.

^bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

CABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV
BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED
END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(d) DOD - 1982

Shuttle flight no.	Payload description	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-1	9 × 8	1 100	41 260
13	C-3B	6 × 7	700	^b 21 450
14-15	S-2B	15 × 25	5 000	18 756
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364
21	S-4	9 × 60	10 000	

^aPayloads are defined in classified addendum (ref. 2).

bABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

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EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

Round trip minimum tug propellant required, 1b 45 450 5 060 43 160 45 495 44 535 9 200 41 550 same as EOS orbit 28 190 same as EOS orbit 28 190 required 28 190 28 755 28 865 840 11 255 tug AV ۲-270/270 19 300/19 300 19 300/19 300 ha/hp, n. mi. 270/270 19 300/19 300 19 300/19 300 1 A.U./19 300 1 800/180 20 000/1000 000/000 000/300 350/350 200/200 350/350 500/500 700/700 as EOS orbit EOS orbit Satellite final orbit 83 same 99.15 i, deg same 90.0 90.0 28.5 28.5 28.5 28.5 28.5 28.5 00 00 0 뒴 350/350 270/270 230/230 350/350 100/100 h,h,n. 270/270 100/100 100/100 350/350 100/100 100/100 Original EOS orbit (e) NASA - 1983 deg 28.5 30.0 30.0 28.5 28.5 28.5 28.5 28.5 28.5 8 8 , Total payload weight, ^b19 320 b53 280 315 200 970 555 8 88 200 9 စ္တ 10ª δ₅₁ b₅₃ p²γ m ₁₃ 9 10 6 22 Total
payload
dimensions, ft
(D × L) 14.5 × 58.5 14.5 × 58 28 9 14.5 × 58 14.5 × 56 14.5 × 58 £ 25 Š 2 14 × 13 14.5 × 14.5 × × × †† × x Tr 7. Synchronous meteorological plus small applications technical - synchronous Low magnetosphere explorer plus middle magnetfollow-on systems demon-Astronomy explorer plus tracking and data relay Polar earth observation plus TOS meteorological magnetosphere explorer Earth physics plus small applications technical Astronomy explorer plus (up) plus high energy stellar astronomy observatory (down) Large solar observatory LST revisit plus fluid Payload description management sortie astronomy sortie osphere explorer Comsat plus high LST revisit plus HESAO revisit stration Shuttle flight no. 6-7 10 77 12 a

 $^{\mathrm{a}}\mathrm{Based}$ on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

og - Continuea	ם ,	g h_a/h_p , n. mi. i, deg. h_a/h_p , n. mi. required required, lb	100/100 5 19 300/19 300 28 725 43 535 0 19 300/19 300	100/100 0 19 300/19 300 14 095 ^C 23 535	200/200 same as EOS orbit	100/100 0 19 300/19 300 28 190 42 495	100/100 0 19 300/19 300 28 190 43 160	100/100 same as BOS orbit	270/270 same as BOS orbit	100/270 same as BOS orbit	100/270 same as BOS orbit	100/100 0 19 300/19 300 28 190 43 360	100/100 0 · 19 300/19 300 28 190 42 530	100/100 28.5 19 300/19 300 26 500 37 055 30 000/16 000
,	Satellite final orbit	ha/h	. 19 300/19 19 300/19	19 300/19		19 300/19	19.300/19		- 8°			19 300/19		
		1, d	5	0	88	0	•	88 .	88		88 	0		% % %
NASA - 1983 - Continued	iginal S orbit	ha/h, n. mi.	100/100	001/001	200/200	100/100	100/100	100/100	270/270	100/270	100/270 100/270	100/100	100/100	100/100
A - 1983 -	ਹਰ ਹਰ	i, deg	28.5	28.5	55.0	28.5	28.5	65.0	55	. 55	55	28.5	28.5	28.5
(e)	Total payload	weignt, lb ^a	^b 52 055	38 305	27 500	^b 51 315	^b 53 280	30 000	20 000	22 000 25 000	19 000 33 000	52 600	_δ 51 495	45 575
;		(D × L)	14.5 × 54	15 × 60	14 × 54	14.5 × 55	14.5 × 55	14 × 51	14 × 30	14 × 32 14 × 45	14 × 38	14.5 × 60	14.5 × 59	14.5 × 60
	Payload	description	Navigation and traffic control plus synchro- nous earth resources	Applications technology	General scientific research module sortie	Follow-on systems demon- stration	Tracking and data relay	General applications module sortie	Crew/cargo	Physics laboratory (up) plus earth observation laboratory (down)	Communications/navigation laboratory (up) plus life sciences laboratory (down)	Comsat plus synchronous meteorological	U. S. domestic communi- cation	Foreign domestic communication plus navigation and traffic control
	Shuttle		. 13	14	15-18	19	50	21-22	23-28	53	30	æ	32-33	34

Based on the minimum propellant required to place payloads in orbit.

boMS must be offloaded in order for the BOS to have the capability to place this payload in a 100 n. mi. circular orbit,

The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAFABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1983 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(e) NASA - 1983 - Concluded

	Payload	Total payload	Total payload	ÖA	Original EOS orbit	Sat	Satellite final orbit	Total tug	Round trip minimum tug
	description	dimensions, it (D × L)	weight,	1, deg	1, deg ha/hp, n. mi.	i, deg	i, deg ha/hp, n. mi.	ΔV required	propellant required, lb
	Navigation and traffic control	14.5 × 52	ο <i>1</i> 6 8η	28.5	100/100	0	19 300/19 300	28 190	ħ1 150
	Polar earth resources	14.5 × 55	b ₁ 6 980	06	001/001	99.15	500/500	same as EOS orbit	
	Polar earth resources	12 × 15 .	2 500	8	001/001	99.15	500/500	060 6	7 660
	Polar earth resources	14.5 × 55	980 و 91م	06	001/001	99.15	200/200	same as EOS orbit	
	Polar earth resources	12 × 15	2 500	8	100/100	99.15	500/500	060 6	7 660
-									

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(e) DOD - 1983

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, 1b
1-10	None			,
11	D-1	10 × 20	6 000	·
12	C-3A C-2	6 × 7 10 × 12	700 2 100	^в 43 535
13	C-2	10 × 12	2 100	^b 42 518
14	C-4	9 × 20	2 300	16 450
15	S-2B	15 × 25	5 000	18 756
16-17	Two S-3	6 × 5 (each)	1 300 (each)	^b 3 591
18	S-4	9 × 60	10 000	
19	Three M-1	5 × 3 (each)	700 (each)	^ъ 7 481
20–23	N-2A	5 × 15	1 400	29 360
24	N-2B	5 × 15	1 400	38 364

^aPayloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

-			(£)	NASA - 1984	1984				
	Payload	Total	Total	O. B	Original EOS orbit	8 13	Satellite final orbit	Total	Round trip
ď	description	dimension, ft (D × L).	weight,	i, deg	h _g /h _p , n. mi.	1, deg	h _a /h, n. mi.	tug AV required	minimum tug propellant required, 1b
LST revisf	LST revisit plus astronomy explorer	91 × 71	7 220	28.5 28.5	350/350 270/270	seme	same as EOS orbit		
Low magne plus re high ma	Low magnetosphere explorer plus radio explorer plus high magnetosphere ex- plorer	14.5 × 58	ος8 6τ _α	28.5	100/100	28.5 28.5 28.5	1 800/180 19 300/19 300 1 A.U./19 300	27 775	40 510
Middle p plore: pair-s	Middle magnetosphere ex- plorer plus solar orbit pair-synchronous	14.5 × 60	45 235	28.5	100/100	28.5	20 000/1000 19 300/19 300	25 905	35 515
Gravíty/ ment (applic poler	Gravity/relative experi- ment C plus small applications technical- polar	14.5 × 59	^b 13 775	90.0	100/100	90.06	300/300 3 000/300	7 555	4 855
Solar o	Solar orbit pair-1 A.U.	14.5 × 52	32 685	28.5	100/100	28.5	1 A.U./1000	21 180	23 965
MESAO revisit	evisit	14 × 13	3 500	30.0	230/230	Same	as EOS orbit		
HESAO r surve	HESAO revisit plus asteroid survey payload	14 × 48	30 500	30.0	230/230	заше	as EOS orbit		
Asteroi	Asteroid survey booster	°10 × 30+ ·	34 575+	30.0	230/230	same	as EOS orbit		
LST revisit	isit	14 × 13	3 500	28.5	350/350	seme	as EOS orbit		
LSO revisit	isit	14 × 13	3 500	30.0	350/350	same	as EOS orbit		
Polar e plus	Polar earth observation plus TOS meteorological	14.5 × 58	^b 19 320	0.06	100/100	99.15	500/500 700/700	11 255	9 200

 $^{\mathbf{a}}$ Based on the minimum propellant required to place payloads in orbit.

^bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

 $^{\mathsf{C}}$ The tug does not have the ΔV capability; therefore, a kick stage was used.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

			(f) NASA	- 1984	- Concluded				
Shuttle	Payload		Total payload	0r BO	Original EOS orbit	St fi	Satellite final orbit	Total tug	Round trip minimum tug
right no.	description	dimensions, ft (D × L)	weight 1b	1, deg	h _a /h, n. mi.	i, deg	ha/hp, n. mi.	ΔV required	propellant required, lb
. 13	Synchronous earth observation plus small applications technicalsynchronous	14.5 × 58	ολ6 6η _α	28.5	100/100	0	19 300/19 300	14 095	41 550
77	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	^c 23 535 <u>.</u>
1.5	Cooperative application - synchronous	14.5 × 52	148 620	28.5	100/100	0	19 300/19 300	28 190	140 980
16-17	Follow-on systems demon- stration	14.5 × 55	51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
18	Tracking and data relay	14.5 × 55	53 280	28.5	100/100	o.	19 300/19 300	28 190	13 160
19	Planetary relay	14.5 × 60	μ8 970	28.5	100/100	0	19 300/19 300	28 190	41 150
20-23	General scientific research module sortie	14 × 54	27 500	55.0	200/200	веше	as EOS orbit		
24-26	General applications module sortie	14 × 51	30 000	65.0	100/100	semes	as EOS orbit		
27	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55.0	200/200	same s	as EOS orbit		
28-29	Dedicated applications module-earth obser- vation sortie	14 × 41	22 500	75.0	100/100	same a	as EOS orbit		
30	Station module - core	14 × 40	20 000	55.0	270/270	same 8	as EOS orbit		
31-36	Crew/cargo	14 × 30	20 000	55.0	270/270	same	as EOS orbit		
37	Comsat plus synchronous meteorological	14.5 × 60	5 2 600	28.5	100/100	0	19 300/19 300	28 190	43 360
38-39	U. S. domestic communi- cation	14.5 × 59	⁶ 51 495	28.5	100/100	. 0	19 300/19 300	28 190	42 530

Based on the minimum propellant required to place payloads in orbit.

DAMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. ml. circular orbit. The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(f) DOD - 1984

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, 1b	Tug propellant required, lb
1-10	None :			
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	^b 43 535
13	C-2	10 × 12	2 100	^ъ 42 518
14-15	S-2A	15 × 25	5 000	^b 47 461
16	S-4	9 × 60	10 000	
17	Three M-1	5 × 3 (each)	700 (each)	^b 7 481
18-21	N-2A	5 × 15	1 400	29 360
22	N-2B	5 × 15	1 400	38 364

^aPayloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

ſ														
	Round trip minimum tug	propellant required, lb	37 1,90	26 455	22 500			ο ^η 2 μ90	- · · · · · · · ·			41 150	6 760	5 060
	Total	ΔV required	26 500	28 755	21 180			13 400				28 190	060 6	7 840
	Satellite final orbit	ha/h, n. mi.	19 300/19 300 30 000/16 000	1 800/180 20 000/1 000	1 A.U./1 000	as EOS orbit	same as EOS orbit planetary	same as EOS orbit planetary	same as EOS orbit	s EOS orbit	same as EOS orbit	same as EOS orbit 19 300/19 300	200/200	400/400 3 000/300
	Sar	1, deg.	28.5 29.0	55.0	55.0	same at	same as E	same as B	same a	seme as	same a	same al	99.15	90.0 90.0
1985	Original EOS orbit	ha/hp, n. mi.	100/100	100/100	100/100	350/350 230/230	230/230 100/100	350/350 100/100	230/230 350/350	350/350	350/350	350/350	100/100	100/100
) NASA - 1985	0r. BOS	i, deg	28.5	55.0	55.0	30.0	30.0	30.0	30.0	28.5	28.5	28.5	90.0	90.0
(g)	Total payload	weight, lb	05ቲ 9ቲ	35 475	29 920	24 500	27 500	^b 52 310	22 800	30 000	30 000	°52 470	_b 16 080	^b 13 080
	Total payload	dimensions, ft $(D \times L)$	14.5 × 56	14.5 × 56	14.5 × 46	14 × 59	14 × · 48	14.5×53	14× 43	14× 60	14× 60	14.5 × 59	14.5 × 52	14.5 × 58.5
	Payload	description	Two radio explorers plus navigation and traffic control	Low magnetosphere explorer plus middle magnetosphere explorer	High magnetosphere explorer	LSO revisit plus high energy stellar astron- omy observatory	HESAO revisit plus comet rendezvous paylosd	LSO revisit plus comet rendervous tug	HESAO revisit plus large radio observatory	Large space telescope (down)	Large space telescope (up)	LST revisit plus synchronous earth resources	Polar earth observation	Earth physics plus small applications technology- polar
	Shuttle	flight no.	τ.	CI.	m	4	v	9	-	80	6	10	я	12

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

^CThe tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V .- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	· ·		1												
	Round trip minimum tug	propellant required, lb	8 550	h3 350	५६म टम	41 150			•		16 150	c37 150			
	Total tug	ΔV required	311 115	28 725	28 190	28 190					26 800	22 700			
	Satellite final orbit	, т. п. ф, в	001/001	19 300/19 300 19 300/19 300	008 61/008 61	19 300/19 300	as EOS orbit	as EOS orbit	same as BOS orbit	s EOS orbit	ary	ary	s EOS orbit	as EOS orbit	s EOS orbit
	Sa fin	1, deg	101.1	. 0 10	0	0	s sme s	same a	Same a	same as	planetary	planetary	Same as	Same a	seme as
Continued	Original EOS orbit	h _a /h, n. mi.	001/001	100/100	001/001	001/001	200/200	100/100	200/200	100/100	100/100	001/001	270/270	270/270	270/270
NASA - 1985 - Continued	ب ₀	i, deg	0.06	28.5	28.5	28.5	55.0	65.0	55.0	75.0	30.0	30.0	55.0	55.0	55.0
(g) NASA	Total payload	weight, lb	ολε γτ ^α	0/1 150	518 15 _q	016 84	27 500	30 000	29 500	22 500	^b 60 270	47 270	20 000	20 000	50 000
	Total payload	dimensions, ft (D × L)	14.5 × 56	14.5 × 60	14.5 × 55	14.5 × 60	14 × 54	14 × 51	14 × 54	17 × 71	14.5 × 55	14.5 × 55	74 × 40	14 × 30	14 × 30
	Payload	description	Tiros plus TOS meteoro- logical	Small application tech- nology - synchronous plus navigation and traffic control	Follow-on systems demonstration	Planetary relay	General scientific research module sortie	General applications module sortie	Dedicated scientific research module - astronomy sortie	Dedicated applications module - earth obser- vation sortie	Venus explorer lander	Jupiter tops orbiter/probe	Station module - core	Station module - others	Crew/cargo
	Shuttle	itigat no.	13	7.5	15-16	17-18	19-51	22-23	54-56	27-28	53	30	æ	32-34	35-40

abased on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

1 11 1	Round trip minimum tug	propellant required, 1b			η3 360	h2 530	44 265		7 660		. 099 L
	Total tug	Ď.			28 190	28 190	28 190	same as EOS orbit	060 6	same as EOS orbit	060 6
	Satellite final orbit	h _a /h, n. mi.	EOS orbit	same as EOS orbit	19 300/19 300	19 300/19 300	19 300/19 300	500/500	500/500	500/500	500/500
	Sat	i, deg	same as	Same as	0		0	99.15	99.15	99.15	99.15
(g) NASA - 1985 - Concluded	Original EOS orbit	h _a /h _p , n. mi.	100/270	100/270 100/270	100/100	100/100	100/100	100/100	100/100	100/100	100/100
3A - 1985	0r:	j, deg	55.0	55.0 55.0	28.5	28.5	28.5	0.06	90.0	90.0	0.06
(g) NAS	Total payload	veight, lb ^a	33 000	25 000	_p 22 600	⁶ 51 495 ·	₅ 4 085	086 91 _q	2 500	980 کتم	2 500
	Total payload	dimensions, ft $(D \times L)$	14 × 58	14 × 45 14 × 38	14.5 × 58	14.5 × 59	14.5 × 60	14.5 × 55	12 × 15	14.5 × 55	12 × 15
	Payload	description	Life sciences laboratory	Earth observation labora- tory (up) comm/nav laboratory (down)	Comsat plus synchronous earth resources	U. S. domestic communi- cations	Synchronous meteorological plus 2 synchronous earth resources	Polar earth resources	Polar earth resources	Polar earth resources	Polar earth resources
	Shuttle	illgnt no.	14	42	143	54-44	94	, L1	81	67	50

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(g) DOD - 1985

Shuttle flight no.	Payload description	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, 1b
1-10	None .			
11	D-1	10 × 20	6 000	
12	C-3A	6 × 7	700	40 484
13-14	C-5	9 × 20	3 300	^b 44 505
15-16	S-2B	15 × 25	5 000	18 756
17	Two S-3	6 × 5 (each)	1 300 (each)	^b 3 591
18-21	S-5	10 × 60	12 000	,

^aPayloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(h) NASA - 1986

Shuttle	Payload	Total payload	Total payload	ioa Io	Original EOS orbit	Se	Satellite final orbit	Total tug	Round trip minimum tug
flight no.	description	dimensions, ft $(D \times L)$	weight, 1b ^a	i, deg	h _а /h, n. mi.	i, deg	h _a /h _p , n. mi.	$^{\Delta V}$ required	propeilant required, lb
1-2	LST revisit plus astronomy explorer	14 × 16	022 t	28.5 28.5	350/350 270/270	same 8	same as EOS orbit		
m	Low magnetosphere explorer plus middle magneto- sphere explorer	14.5 × 56	25 490	90.0	100/100	90.0	1 800/180 20 000/1 000	17 390	16 470
4	Small applications tech- nology polar	14.5 × 52	^b 12 170	0.06	100/100	90.0	3 000/300	7 515	h 750
2-6	HESAO revisit	14 × 13	3 500	30.0	230/230	same a	as EOS orbit	•	
4-8	LSO revisit	14 × 13	3 500	30.0	350/350	Same 8	as EOS orbit		
9-10	LRO revisit	14 × 13	3 500	30.0	350/350	ваше Е	as EOS orbit		
ជ	Polar earth observation plus TOS meteorological	14.5 × 58	^b 19 320	90.0	100/100	99.15	500/500 700/700	11 255	9 200
12	Synchronous earth observation plus small applications technology - synchronous	14.5 × 58	ο <i>τ</i> ο 6τ _α	28.5	100/100	0	19 300/19 300	28 190	41 550
13	Polar earth resources	14.5 × 52	^b 16 980	0.06	100/100	99.15	200/200	same as EOS orbit	
7,7	Polar earth resources	6 × 12	2 500	0.06	100/100	99.15	500/500	060 6	7 660
15	Applications technology	15 × 60	38 305	28.5	100/100		19 300/19 300	14 095	^c 23 535
16-17	Follow-on systems demonstration	14.5 × 55	⁸ 51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
18-20	General applications module sortie	14 × 51	30 000	65.0	100/100	8 8 me 8	same as EOS orbit	•	

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	Round trip minimum tug	propellant required, 1b			ς _μ 3 065				42 530	76 t St	35 460	1 150	. 22 500
	Total	ΔV required			24 000				28 190	28 190	25 835	28 190	21 180
	Satellite final orbit	ha/h, n. mi.	as EOS orbit	same as EOS orbit	planetary	as EOS orbit	as EOS orbit	same as EOS orbit	008 61/008 61	19 300/19 300	008 61/008 61	19 300/19 300	1 A.U./1 000
	Se f1r	i, deg	SВШе	Same	plan	same	ваше	ваше	0	0	28.5	0	90.0
NASA - 1986 - Concluded	Original EOS orbit	ha/h, n. mi.	200/200	100/100	100/100	270/270	270/270	100/270	100/100	100/100	100/100	100/100	100/100
3A - 1986	.ς Θ	i, deg	55.0	75.0	30.0	55.0	55.0	55.0	28.5	28.5	28.5	28.5	90.0
(h) NAS	Total payload	weight, lb ^B	29 500	22 500	₅ 3 585	20 000	20 000	22 000	₆ 51 495	^b 51 315	44 280	48 970	^d 29 920
	Total payload	dimensions, ft $(D \times L)$	14 × 54	14 × 41	14.5 × 55	14 × 40	14 × 30	14 × 32	14.5 × 59	14.5 × 60	14.5 × 52	14.5 × 52	14.5 × 46
	Payload	description	Dedicated scientific research module - astronomy sortie	Dedicated applications module - earth observ- ation sortie	Uranius tops orbiter/probe	Station module-core	Crew/cargo	Physics laboratory (down)	U. S. domestic communication	Foreign domestic communication plus synchronous meteorological	Foreign domestic communication	Foreign domestic communication	High magnetosphere explorer
	Shuttle	ilignt no.	21-24	25-26	27	28-30	31-38	39	10-41	टन	क्ष-६ व	54	911

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

 $^{\rm d}_{\rm ABES}$ will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(h) DOD - 1986

Shuttle flight no.	Payload description	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None :			
11	D-1	10 × 20	6 000	
12	C-2	10 × 12	2 100	^b 42 518
13	C-3B Two S-3	6 × 7 6 × 5	700 1 300	^c 20 452
14	S-2B	15 × 25	5 000	18 756
15	Three M-1	5 × 3 (each)	700 (each)	⁶ 7 481
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364

^aPayloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

CABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	Round trip minimum tug	propeliant required, lb		090 04	ևև 535	00S 171	^c 37 150					9 200	2 090	
	Total tug	ΔV required		27 690	28 755	28 865	22 700					11 255	7 840	same as EOS orbit
	Satellite final orbit	h _a /h, n. mi.	as EOS orbit	19 300/19 300 1 A.U./19 300	1 800/180 20 000/1000	19 300/19 300 1 A.U./19 300	planetary same as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	500/500	3 000/400	. 500/500
,	Sat fina	i, deg	emes	28.5	00	00	planetary	same	same	same	same	99.15	90.06	99.15
1987	Original EOS orbit	ha/hp, n. mi.	350/350 270/270	100/100	100/100	100/100	100/100 230/230	230/230	350/350	350/350	350/350	100/100	100/100	100/100
MASA - 1987	Or EO	i, deg	28.5 28.5	28.5	28.5	28.5	30.0	30.0	28.5	30.0	30.0	90.0	90.0	90.0
(i)	Total payload	метвич, 1Ъ ^а	h 020	^р ьв 100	^b 53 555	^b 51 320	47 270 21 000	3 500	3 500	3 500	3 500	⁵ 19 320	^b 13 080	₀ 16 980
	Total payload	(D × L)	14 × 16	14.5 × 49	14.5 × 56	14.5 × 58	14.5 × 55 14 × 46	14 × 13	14 × 13	14 × 13	14 × 13	14.5 × 58	14.5 × 58.5	14.5 × 52
	Payload		LST revisit plus astronomy explorer	Radio explorer plus gravity/relativity experiment D	Low magnetosphere explorer plus middle magneto- sphere explorer	Foreign domestic communi- cation plus high magnetosphere explorer	Jupiter tops orbiter/probe (up) plus high energy stellar astronomy laboratony (Ann.)	HESAO revisit	LST revisit	LSO revisit	LRO revisit	Polar Earth observation plus TOS meteorological	Earth physics plus small applications technical-polar	Polar earth resources
	Shuttle	0	н	· · · · · · · · · · · · · · · · · · ·	m	a	v	2-9	80	9-10	11-12	13	14	15

 $^{\mathbf{a}}$ Based on the minimum propellant required to place payloads in orbit.

boms must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

^CThe tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(i) NASA - 1987 - Continued

Shuttle	Payload	Total payload	Total payload	장	Original EOS orbit	Ss	Satellite final orbit	Total tug	Round trip minimum tug
Illght no.	dlescription	dimensions, ft $(D \times L)$	weight, 1b ^a	i, deg	ha/h, n. mi.	i, deg	ha/h, n. mi.	ΔV required	propellant required, lb
16	Polar earth resources	16 × 12	2 500	0.06	100/100	99.15	200/200	060 6	7 660
17	Polar earth resources	14.5 × 52	086 91 _q	90.0	100/100	99.15	500/500	same as EOS orbit	
18	Polar earth resources	6 × 12	2 500	90.0	100/100	99.15	500/500	060 6	7 660
19	Synchronous earth resources plus small applications technical synchronous	14.5 × 58	ο <i>γ</i> ο 6τ ₀	28.5	100/100	0	19 300/19 300	28 190	41 550
20-21	Follow-on systems demonstration	14.5 × 55	b ₅₁ 315	28.5	100/100		19 300/19 300	28 190	42 495
22-23	Tracking and Data Relay	14.5 × 55	⁵ 53 280	28.5	100/100	0	19 300/19 300	28 190	13 160
24-28	Dedicated scientific research module - astronomy sortie	11 × 54	29 500	55.0	200/200	same	same as EOS orbit		
29-30	Dedicated applications module-earth observation sortie	14 × 41	22 500	. 75.0	100/100	same	same as EOS orbit		
31-32	Station module-core	14× 40	20 000	55.0	270/270	same 1	as EOS orbit		
33-40	Crew/cargo	14× 30	20 000	55.0	270/270	звше	same as EOS orbit		
41-42	U.S. domestic communi- cation	14.5 × 59	δ ₅₁ 495	28.5	100/100		19 300/19 300	28 190	42 530

^aBased on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAFABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

						
	Round trip minimum tug	propellant required, 1b	150	56ग टग	37 055	43 535
	Total tug	ΔV required	28 190	28 190	26 500	28 725
	Satellite final orbit	ha/hp, n. mi.	19 300/19 300	19 300/19 300	19 300/19 300 30 000/16 000	19 300/19 300 19 300/19 300
	Se	i, deg	0	0	28.5 29.0	v.0
oncluded	Original EOS orbit	i, deg ha/hp, n. mi. i, deg ha/hp, n. mi	100/100	100/100	100/100	100/100
- 1987 - C	ង់ខ្ល	i, deg	28.5	28.5	28.5	28.5
(i) NASA - 1987 - Concluded	Total payload	weight,	016 84	b ₅₁ 315	35 020	^b 52 055
)	Total payload	dimensions, ft $(D \times L)$	14.5 × 52	14.5 × 60	14.5 × 60	14.5 × 60
	Payload	description	Foreign domestic communication	Foreign domestic communication plus synchronous meteorological	Foreign domestic communication plus navigation and traffic control	Navigation and traffic control plus foreign domestic communi- cation
	Shuttle	ilignt no.	E 7	TT TT	1,5	91

 $^{\mathbf{a}}$ based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(i) DOD - 1987

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	·
12	C-3B	6 × 7	700	b ₂₁ 450
13	C-5	9 × 20	3 300	^c 44 505
14-15	S-2A	15 × 25	5 000	^c 47 461
16-17	S-5	10 × 60	12 000	
18	Three M-1	5 × 3 (each	700 (each)	c7 481
19-22	N-2A	5 × 15	1 400	29 360
23	N-2B	5 × 15	1 400	38 364

^aPayloads are defined in classified addendum (ref. 2).

bABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

COMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(J) NASA - 1988

Round trip minimum tug	propellant required, lb		16 470	067 07	ηS 1460	41 150			41 515	•	41 515	6 760	η 550	^c 23 535
Total	ΔV required		17 390	27 690	25 840	28 190		 -	28 410		28 410	060 6	28 410	11 095
Satellite final orbit	ha/hp, n. mi.	as EOS orbit	1 800/180 20 000/1 000	19 300/19 300 1 A.U./19 300	19 300/19 300	as EOS orbit 19 300/19 300	as EOS orbit	same as EOS orbit	as EOS orbit 19 300/19 300	as EOS orbit	19 300/19 300	500/500	19 300/19 300	19 300/19 300
Se	1, deg	same	28.5 28.5	28.5 28.5	30.0	same 0	same	ваше	semes 0	Same	0	99.15	0	0
Original EOS orbit	ha/hp, n. mi.	230/230 270/270	100/100	100/100	100/100	350/350	350/350	350/350	350/350	350/350	350/350	100/100	100/100	100/100
Or EO	i, deg	28.5 28.5	28.5	28.5	28.5	28.5	30.0	30.0	30.0	30.0	30.0	90.0	28.5	28.5
Total payload	weight, lb ⁸	ų 220	25 490	016 84	^b 56 280	148 970	27 000	27 000	^b 52 835	3 500	^b 52 835	₀ 80 91 _q	016 6tq	38 305
	dimensions, ft (D × L)	91 × 11	14.5 × 56	14.5 × 58	14.5 × 60	. 14.5 × 59	14 × 54	14 × 54	14.5 × 59	14 × 13	14.5 × 59	14.5 × 52	14.5 × 58	15 × 60
Payload	description	HESAO revisit plus astron- omy explorer	Low magnetosphere explorer plus middle magnetosphere explorer	Foreign domestic communi- cation plus high mag- netosphere explorer	Optical interferometer pair	LST revisit plus syn- chronous earth re- sources	Large solar observatory (down)	Large solar observatory (up)	LSO revisit plus syn- chronous earth observ- ation	LRO revisit	LRO revisit plus syn- chronous earth resources	Polar earth observation	Synchronous earth resources plus small applications technical	Applications technology
Shuttle	iiignt no.	1-2	т	<u>-</u>	5	6-7	œ	٥	10	11	12	13	77	15

Based on the minimum propellant required to place payloads in orbit.

DMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

^cThe tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND (j) NASA - 1988 - Continued

		Total	Total	ė	Ortainal	ď	So+0114+0	- Total	Bound +win
Shuttle	Payload	payload	payload	i Ĉ	EOS orbit	fine	final orbit	tug	minimum tug
riignt no.	description	dimensions, ft $(D \times L)$	weight,	i, deg	h _a /h, n. mi.	1, deg	h _a /h, n. mi.	ΔV required	propellant required, lb
16	Small applications tech- nical plus TOS meteorological	14.5 × 58	065 12 _q	·06	100/100	90 101.1	3 000/300 700/700	14 995	13 170
17-18	Follow-on systems demon- stration	14.5 × 55	^b 51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
. 61	Tracking and Data Relay	14.5 × 55	^b 53 280	28.5	100/100	0	19 300/19 300	28 190	43 160
20-22	General applications module sortie	14 × 51	30 000	. 49	100/100	ввше	same as EOS orbit		
23-26	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55	200/200	вяше	same as EOS orbit		
27-28	Dedicated applications module earth observation sortie	14 × 41	22 500	75	. 100/100	звше	same as EOS orbit		
53	Venus explorer lander	14.5 × 55	₂ 60 270	30	100/100	plane	planetary	26 800	150
30–37	Crew/cargo	14 × 30	20 000	55	270/270	звше	same as EOS orbit		
88	Physics laboratory (up)	14 × 32	22 000	55	100/270	same	same as EOS orbit		
39	Cosmic ray laboratory part I (up) plus cosmic ray laboratory - part II (up)	14× 59	°54 000	55	270/270	ваше	same as EOS orbit		

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

CABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

EARTH ORBIT SHUTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

			(1) NASA	- 1988 -	(1) NASA - 1988 - Concluded				
Shuttle	Payload	Total payload	l	Or:	Original EOS orbit	Sa	Satellite final orbit	Total tug	Round trip minimum tug
flight no.	description	dimensions, ft $(D \times L)$.	weight, lb ^a	1, deg	1, deg h_{a}/h_{p} , n. mi. i, deg h_{a}/h_{p} , n. mi.	i, deg	ha/hp, n. mi.	ΔV required	propellant required, lb
017	Comsat plus synchronous earth resources	14.5 × 58	^b 52 600	28.5	100/100	0	19 300/19 300	28 190	1,3,360
τ,	Comsat plus synchronous meteorological	14.5 × 60	600 حج	28.5	100/100	0	19 300/19 300	28 190	13 360
६५-८५	U.S. Domestic communication	14.5 × 59	56† 15 _q	28.5	100/100	0	19 300/19 300	28 190	42 530
77	Foreign domestic communication plus synchronous earth resources	14.5 × 58	^b 51 315	28.5	100/100	0	19 300/19 300	28 190	42 495

^aBased on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(j) DOD - 1988

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	^b 43 535
13-14	S-2B	15 × 25	5 000	18 756
15	Two S-3	6 × 5 (each)	1 300 (each)	^b 3 591
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364

a Payloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	Round trip minimum tug	propellant required, lb		16 470	22 500	38 360	23 965						. 099 1	090 5	°23 535
	Total	ΔV required		17 390	21 180	26 520	21 180			-		same as EOS orbit	060 6	7 840	14 095
	Satellite final orbit	ha/hp, n. mi.	same as EOS orbit	1 800/180 20 000/1000.	1 A.U./1000	19 300/19 300 30 000/16 000	1 A.U./1000	as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	200/200	200/200	3 000/300	19 300/19 300
	Se	i, deg	same	55	55	30	28.5	88446	ваше	same	ввше	99.15	99.15	88	0
1989	Original EOS orbit	h _a /h, n. mi.	350/350 270/270	100/100	100/100	100/100	100/100	230/230	230/230	350/350	350/350	100/100	100/100	001/001	100/100
NASA - 1989	PO 03	i, deg	28.5 28.5	55.0	55.0	30.0	28.5	30.0	30.0	30.0	30.0	90.0	90.0	90.0	28.5
(k)	Total payload weight,		4 220	25 490	29 920	47 780	32 685	21 000	3 500	3 500	3 500	₁ 6 980	2 000	b ₁₃ 080	38 305
	Total payload dimensions, ft (D × L)		14 × 16	14.5 × 56	14.5 × 46	14.5 × 60	14.5 × 52	14 × 46	14 × 13	14 × 13	14 × 13	14.5 × 55	12 × 27	14.5 × 58.5	15 × 60
	Payload	description	LST revisit plus astronomy explorer	Low magnetosphere explorer plus middle magneto- sphere explorer	High magnetosphere explorer	Solar orbit pair synchron- ous plus navigation and traffic control	Solar orbit pair - 1 A.U.	High energy stellar astronomy omy observatory (up)	HESAO revisit	LSO revisit	LRO revisit	Polar earth resources	Polar earth resources plus polar earth observation	Earth physics plus cooperative applications-polar	Applications technology
	Shuttle	ilignt no.	1-2	т	.=	۲.	9	-	8-9	10-11	12-13	7.7	15	16	17

 $^{\mathsf{A}}$

^bOMS must be offloaded in order for the BOS to have the capability to place this payload in a 100 n. mi. circular orbit.

The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

			(k) NASA	- 1989 -	(k) NASA - 1989 - Continued				
Shuttle	Payload		Total payload	Or EO	Original EOS orbit	Sa	Satellite final orbit	Total tug	Round trip minimum tug
illgnt no.	description	dimensions, ft $(D \times L)$	weight, lb ^a	i, deg	h _a /h _p , n. mi.	1, deg	ha/h, n. mi.	ΔV required	propellant required, lb
18	Navigation and traffic control plus small applications cations technical synchronous	14.5 × 60 ·	ο Δη τ5 _α	28.5	001/001	50	19 300/19 300 19 300/19 300	28 725	43 350
19	Small applications tech- nical polar plus TOS meteorological	14.5 × 58	^b 21 590	90.0	001/001	90	3 000/300 700/700	14 995	13 170
20-21	Follow-on systems demon- stration	14.5 × 55	^b 51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
22	Synchronous earth observation	14.5 × 60	η8 970	28.5	001/001	0	19 300/19 300	28 190	41 150
23	General applications module sortie	14 × 51	30 000	65.0	100/100	веше	same as EOS orbit		
24-28	Dedicated scientific research module - astronomy sortie	16 × 41	29 500	55.0	200/200	веше	same as EOS orbit		
29-31	Dedicated applications module earth observation sortie	14 × 41	22 500	75.0	100/100	same	same as EOS orbit		
32	Uranius tops orbiter/probe	14.5 × 55	b _{53 575}	30.0	100/100	planetary	tery	24 000	ch3 065
33-40	Crew/cargo	14 × 30	20 000	55.0	270/270	same	same as EOS orbit		
1,1	Comsat	14.5 × 52	572 67 _q	28.5	100/100		19 300/19 300	28 190	41 505
42-43	U.S. domestic communication	14.5 × 59	_φ 15 _q	28.5	100/100	0	19 300/19 300	28 190	42 530

abased on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	Original Satellite Total Round trip EDS orbit final orbit tug minimum tug	i, deg h _a /h _p , n. mi. 1, deg h _a /h _p , n. mi. required required, lb	100/100 0 19 300/19 300 28 190 42 495	100/100 99.15 500/500 same as EOS orbit	100/100 99.15 500/500 9 090 7 660
			28 190	same as EOS orbit	060 6
	tellite al orbit	h _a /h, n. mi.	19 300/19 300	200/200	500/500
	Sa	i, deg	0	99.15	99.15
(k) NASA - 1989 - Concluded	iginal S orbit	ha/h, n. mi.	100/100	100/100	100/100
- 1989 -	Origi EOS o	i, deg	28.5	0.06	90.0
(k) NASA		weight, lb ⁸	518 15 _q	086 91 _q	2 500
	Total payload	dimensions, ft $(D \times L)$	14.5 × 60	14.5 × 55	12 × 15
	Payload	description	Foreign domestic communication plus synchronous meteorological	Polar earth resources	Polar earth resources
	Shuttle	flight no.	77	94-54	47-48

Based on the minimum propellant required to place payloads in orbit.

DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

(k) DOD - 1989

Shuttle flight no.	Payload description	Payload dimensions, ft $(D \times L)$	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	김	10 × 20	9 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	ρ ₄ 3 535
13	S-2B	15 × 25	2 000	18 756
71	Two S-3	6 × 5 (each)	1 300 (each)	b3 591
15-16	S-5	10 × 60	12 000	
17	Three M-1	5 × 3 (each)	700 (each)	7 481

Payloads are defined in classified addendum (ref. 2).

**DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

	Round trip minimum tug	propellant required, lb	35 065	34 815	16 470	1 750	7 590						ևլ 550
	ii	ΔV prequired re	25 835	25 835	17 390	7 515	8 875	-	15 400				28 190
	Satellite final orbit	ha/h, n. mi.	19 300/19 300	same as EOS orbit	1 800/180 20 000/1000	3 000/300	300/300	as EOS orbit	OS orbit	as EOS orbit	BOS orbit	same as EOS orbit	19 300/19 300
	Sate	i, deg	28.5	seme a: 28.5	88	8	90 99,15	seme a:	same as E planetary	Same at	same as	Same as	
.990	Original EOS orbit	ha/hp, n. mi.	100/100	350/350	100/100	100/100	100/100	230/230	350/350	230/230	350/350	350/350	100/100
NASA - 1990	200	i, deg	28.5	28.5	90.0	0.06	0.09	30.0	30.0	30.0	28.5	30.0	28.5
. (1)	Total payload	weight lb ^a	43 605	41 635	925 490	°12 170	°18 410	25 500	41 500 1 :	3 500	3 500	25 500	с ₁ ,9 970
	Total payload	dimensions, ft (D × L)	14.5 × 56	14.5 × 57	14.5 × 56	14.5 × 52	14.5 × 59	15 × 35.5	d ₁ h × h3+'	14 × 13	14 × 13	15 × 35.5	14.5 × 58
		description	Radio explorer plus foreign domestic communication	LST revisit plus radio explorer	Low magnetosphere explorer plus middle magneto- sphere explorer	Small applications tech- nical - polar	Gravity/relativity experiment E plus polar earth observation	LRO revisit plus Mars sample return payload	LSO revisit plus Mars sample return booster	HESAO revisit	LST revisit	LRO revisit plus Mars sample return payload	Synchronous earth observation plus small application technical synchronous
ļ	Shuttle	flight no.	τ	N	m	4	٠,	9	7-8	01-4	п	12	13

Based on the minimum propellant required to place payloads in orbit.

COMS must be offloaded in order for the EDS to have the capability to place this payload in a 100 n. mi. circular orbit. DABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

The tug does not have the AV capability; therefore, a kick stage was used.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR AV BEYOND

(1) NASA - 1990 - Concluded

Shuttle	Payload	Total payload	Total payload	6 B	Original EOS orbit	St	Satellite final orbit	Total tug	Round trip
	description	dimensions, it (D × L)	weight,	i, deg	ha/hp, n. mi.	1, deg	ha/hp, n. mi.	ΔV . required	propellant required, lb
1,1	Tiros plus TOS meteoro- logical	14.5 × 56	^Δ 17 370	90.0	100/100	1.101	700/700	11 120	8 550
15-16	Follow-on systems demon- stration	14.5 × 55	^b 51 315	28.5	100/100	0	19 300/19 300	28 190	५६ ५५
17-18	Planetary relay	14.5 × 60	016 84	28.5	100/100	. 0	19 300/19 300	28 190	41 150
19-23	Dedicated scientific research module-satronomy sortie	. 45× 41	29 500	55.0	200/200	Bame Bame	same as EOS orbit		
24-27	Dedicated applications module earth observ- ation sortie	14 × 41	22 500	75.0	100/100	звше	same as EOS orbit		
28–35	Crew/cargo	14 × 30	50 000	55.0	270/270	same as	as EOS orbit		
36	Communications/navigations lab (up) life sciences laboratory (down)	14 × 38 14 × 58	19 000 33 000	55.0 55.0	100/270 100/270	звше	same as EOS orbit		
37	Space manufacture labora- tory (up) earth observ- ation lab (down)	24 × 41 24 × 45	25 000	55.0 55.0	100/270 100/270	вяше	same as EOS orbit		
38-39	U.S. domestic communication	14.5 × 59	₀ 51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
O†	Foreign domestic communication plus synchronous meteorological	14.5 × 60	b ₅₁ 315	28.5	100/100		19 300/19 300	28 190	42 495
143	High magnetosphere explorer	14.5 × 46	°29 920	0.06	100/100	96	1 A.U/1000.	21 180	22 500

 $^{\mathbf{a}}_{\mathbf{b}}$ Based on the minimum propellant required to place payloads in orbit.

^DOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit..

CABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1979 - Concluded

(1) DOD - 1990

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None		·	
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	¹ 43 535
13-14	S-2A	15 × 25	5 000	⁶ 47 461
15	Three M-l	5 × 3 (each	700 (each)	⁶ 7 .481
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364

^aPayloads are defined in classified addendum (ref. 2).

bOMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

i

TABLE VI - EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985

					-				
	Booster	required		EOS	BOS	Centaur	Centaur	EOS	Centaur
(26 Hz 200)	Satellite final orbit	ha/hp, n. mi.		same as EOS orbit	same as EOS orbit	1 800/180 19 300/19 300 20 000/1000	19 300/19 300 1 A.U./19 300	same as EOS orbit	19 300/19 300
	S f3	i, deg		28 \$	188	000	0 0	78S	ο .
	Original EOS orbit	ha/hp, n. mi.		200/200 270/270	200/200 270/270	100/100	100/100	230/230	100/100
	Ori BOS	i, deg	(a) NASA - 1979	28.5 28.5	28.5 28.5	28.5	28.5	30.0	28.5
	Maximum total payload	weight, lb ^a	(a) NAS	5 020	13 720	37 275	37 075	21 000	37 295
	Total payload	dimensions, ft		01 × 11	14 × 40	10 × 58	12 × 51	34 × 41	12 × 57
	Payload description			Bio research module sortie plus astronomy explorer	Large telescope mirror test plus astronomy explorer	Low magnetosphere explorer plus small applications tech. sync. plus middle magnetosphere explorer	Medical network plus high magnetosphere explorer	High energy stellar astronomy observatory (UP)	Cooperative application sync. plus medical network
	Shuttle flight no.			ri H	8	м	.4	۲۸	9

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(a) DOD - 1979

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, 1b
1	None			EOS
2	None			EOS

^aPayloads are defined in classified addendum (ref. 2)

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

	Total	(b) NASA - 1980 Maxium		Original	Sat	Satellite	
	payload dimensions, ft	total payload veight, 15ª	i, deg	EOS orbit R ha/hp,n.mi.	fine 1, deg	final orbit es h / h , n. mi.	Booster required
l	14 × 37	000 9	90.06	125/125	same s	as EOS orbit	EOS
	1½ × 37	5 700	28.5	200/200	seme e	 as EOS orbit	EOS
	14 × 37	7 100	28.5	200/200	same	as EOS orbit	EOS
	14 × 37	2 000	28.5	200/200	seme s	as EOS orbit	EOS
	. τη × ητ	5 700	28.5 28.5	200/200 350/350	same s	as EOS orbit	EOS
	14 × 13	3 500	30.0	230/230	seme a	same as EOS orbit	SOS
	6.5 × 44	16 420	28.5	100/100	0	19 300/19 300	Agena
	6 × 28	006 η _Q	99.15	100/100	99.15 101.1	500/500 700/700	2 FW-4S
	10 × 39	16 965	28.5	100/100	0	19 300/19 300	Agena
	10 × 57	37 315	28.5	100/100	0	19 300/19 300	Centaur
	12 × 57	37 490	28.5	100/100	28.5 28.5 0	1800/180 20 000/1000 19 300/19 300	Centaur
	12 × 57	38 190	28.5	100/100	0	19 300/19 300	Centaur
	10 × 40	15 820	28.5	100/100	0	19 300/19 300	Agena

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster. DOMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND (b) NASA - 1980 - Concluded

Booster	required	Centaur	Centaur	Centaur	Centaur	Centaur	2 FW-4S
Satellite final orbit	i, deg ha/hp, n. mi	008 61/008 61	1800/180 19 300/19 300 30 000/16 000	19 300/19 300 1 A.U./19 300	19 300/19 300	planetary	400/400 3000/300
Se	i, deg	0	28.5 28.5 29.0	28.5 28.5	0	_ µ-	90.0
Original EOS orbit	h _a /h, n. mi.	100/100	100/100	100/100	100/100	100/100	100/100
	1, deg	28.5	28.5	28.5	28.5	30.0	90.06
Maximum total navload	weight, 1ba	37 615	37 370	35 790	37 615	35 470	2 600
Total	dimensions, ft	10 × 55	10 × 58	10 × 40	10 × 57	70 × 42	6.5 × 28.5
Pavload	description	Synchronous earth observation plus U. S. domestic communication	Low magnetosphere explorer plus foreign domestic communication plus navi- gation and traffic con- trol	Radio explorer plus high magnetosphere explorer	U. S. domestic communi- cation plus synchronous meteorological	Venus explorer	Earth physics plus small applications tech polar
Shuttle	flight no.	91	17	18	19	8	เร

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(b) DOD - 1980

Shuttle flight no.	Payload description	Payload dimensions, ft (D × L)	Payload weight, 1b	Tug propellant required, 1b
1-10	None			EOS
11	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
12	N-2A C-3A C-1	5 × 15 6 × 7 9 × 8	1 400 700 1 100	Centaur
13	Three M-1	5 × 3 (each)	700 (each)	Agena
14	S-4	9 × 60	10 000	EOS
15	S-2B	15 × 25	5 000	Agena

 $^{^{\}mathbf{a}}$ Payloads are defined in classified addendum (ref. 2)

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND (c) NASA - 1981

			Most		041201	S	0++114+0	
	payload		total payload	P	EOS orbit	fir	اد	Booster
description dimensions, ft	dimensions, ft		weight, lb	i, deg	ha/h, n. mi.	1, deg	ha/h, n. mi.	Required
Station module-core $1h \times h0$	0η × ητ		20 000	55	270/270	заше	as EOS orbit	EOS
Station module-others 14 x 30	14 × 30		20 000	55	270/270	seme	as EOS orbit	EOS
Station crew/cargo 14 x 30	1h × 30		20 000	55	270/270	зате	as EOS orbit	EOS
Life sciences lab (up) 14 x 58	14 × 58		33 000	55	100/270	same	as EOS orbit	EOS
Earth observation lab (up) $1^{l_1} \times l_2$	17 × 7	2	25 000	55	100/270	веще	as EOS orbit	EOS
General scientific research 14 x 5 module sortie	×	75	27 500	55	200/200	SBILL	same as EOS orbit	SOS
General applications module 14 x 5 sortie	×	ız.	30 000	65	001/001	same	as EOS orbit	SOE
Earth resources sortie 14 x 43.5	7 × 7T	3.5	009 9	8	125/125	same	as EOS orbit	EOS
Astronomy sortie plus astron- omy explorer	र भूर	o.	6 420	28.5	200/200 270/270	same	as EOS orbit	SOG
HESAO revisit plus astron- lt x our sortie	×	50	9 200	28.5	200/200	same	as EOS orbit	SOH
Manned work platform sortie	1¼ ×	37	6 700	28.5	200/200	звше	same as EOS orbit	BOS
Large space telescope	×	- 09	30 000	28.5	350/350	same	as EOS orbit	EOS
Applications technology plus 15 x synchronous earth resources	×	95	43 420	28.5	100/100	0 .	19 300/19 300	Centaur
Small applications tech- nology synchonous plus foreign domestic communication	6.5 × 4	77	16 420	28.5	100/100	0	19 300/19 300	Agens
Earth physics plus small 6.5 × 50.5 applications technical-polar plus polar earth observation	6.5 × 5	0.5	^{b,c} 18 520	96	100/100	90 . 90 99.15	400/400 3000/300 500/500	Agena

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster. DOMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit. CIf minimum propellant usage is assumed, then no OMS offloading would be required,

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND (c) NASA - 1981 - Continued

Booster	required	Centaur	Centaur	3 FW-4S	Agena	Agena	Centeur	Centaur	Agena	Centaur	Agena
Satellite final orbit	ha/h, n. mi.	19 300/19 300	19 300/19 300	500/500 700/700	19 300/19 300 19 300/19 300 30 000/16 000	1800/180 20 000/1000 1 A.U./1000	38 300/38 300 1 A.U./38 300	 Planetary	19 300/19 300	19 300/19 300	19 300/19 300 19 300/19 300
Sat	i, deg	0	0	99.15	28.5 28.5 29.0	55 55	28.5 28.5	Pl	0	0	28.5 5
Original EOS orbit	ha/hp, n. mi.	100/100	100/100	100/100	100/100	100/100	100/100	100/100	100/100	100/100	100/100
	1, deg	28.5	28.5	99.15	28.5	55	28.5	30	28.5	28.5	28.5
Maximum total payload	weight, 1ba	37 470	38 770	560 B _q	17 240	17 620	016 On	12 170	17 240	37 615	16 520
Total payload	dimensions, ft	12. × 57	12 × 60	12 × 40	14 × ₹	10 × 52	12 × 50	10 × 42	6.5× 44	10× 57	5× 40
Раулова	description	Follow-on systems demon- stration plus foreign domestic communication	Follow-on systems demon- stration plus tracking and data relay	Two Polar earth resources plus Tiros	Radio explorer plus foreign domestic communication plus navigation and traffic control	Low magnetosphere explorer plus middle magnetosphere explorer plus high magnetosphere explorer	Radio interferometer synchronous plus gravity/relativity experiment B	Mars Viking	Comsat plus foreign domestic communications	U.S. domestic communication plus synchronous meteorological	Foreign domestic communication plus navigation and traffic control
Shuttle	flight no.	23	57	25	56	27	58	59	30	ಜ	32

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster, ^bOMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STACES USED FOR AV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

Shuttle	Payload	Total payload	Maximum total payload	50g	Original EOS orbit	Sar	Satellite Yngl orbit	Booster
		dimensions, ft	dimensions, ft weight, lb^a i, deg h_a/h_p , n , mi , i, deg h_a/h_p , n , mi .	i, deg	ha/hp, n. mi.	i, deg	ha/hp, n. mi.	required
			(c) NASA - 1981 - Concluded	81 - Concl	uded			
33	Two polar earth resources plus TOS meteorological	12 × 56	960 8 _q	99.15	100/100	99.15	500/500 700/700	3 FW-4S
1 6	Foreign domestic communication plus navigation and traffic control	5 × 40	16 520	28.5	100/100	28.5	19 300/19 300 30 000/16 000	Agena

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

**ONS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(c) DOD - 1981

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			EOS
11	Three M-1	5 × 3 (each)	700 (each)	Agena
12	S-4	9 × 60	10 000	EOS
13-14	S-2A	15 × 25	5 000	Centaur
15	C-4 C-3B	9 × 20 6 × 7	2 300 700	Agena
16	C-1	9 × 8	1 100	Agena

a Payloads are defined in classified addendum (ref. 2)

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ÅV'BEYOND

									· · · · · ·		
Booster	required	EOS Agena	EOS	Agena	EOS	EOS	EOS Centaur plus some other kick stage	2 FW-4S	Centaur	EOS FW-4S	Centaur
ellite orbit	ha/hp, n. mi.	270/270 19 300/19 300 19 300/19 300	s EOS orbit	1800/180 20 000/1000 1 A.U./1000	s EOS orbit	s EOS orbit	s EOS orbit anetary	500/500 700/700	19 300/19 300	EOS orbit \$00/400	19 300/19 300
Sat. fina	i, deg	28.5 28.5 0	same a	0 0 0	seme s	same a	seme a	99.15	0	seme as	0
riginal OS orbit	h _а /h, п. mi.	001/001	350/350 270/270	001/001	230/230	230/230 200/200	350/350 350/350		100/100	125/125	100/100
Ö	1, deg	28.5	28.5 28.5	06	30	30 28.5	28.5	99.15	28.5	06	28.5
Maximum total payload	weight, lb ^a	17 540	4 220	^{b,c} 17 620	21 000	9 200	38 000+	006 n _q	37 470	7 300	38 470
		10 × 51	14 × 16	10 × 52	34 × 45	14 × 50	14 × 43+	6 × 28	12 × 51	14 × 48.5	12 × 59
Payload	description	Astronomy explorer plus foreign domestic communication plus synchronous earth resources	LST revisit plus astronomy explorer	Low magnetosphere explorer plus middle megnetosphere explorer plus high mag- netosphere explorer	High energy stellar astronomy observatory (up)	HESAO revisit plus astronomy sortie	LST revisit plus comet rendezvous booster	Polar earth observation plus TOS meteorological	Synchronous earth resources plus follow-on demonstration	Earth resources sortie plus earth physics	Synchronous meterological plus synchronous earth re- sources plus follow-on systems demonstration
Shuttle	flight no.	н .	ο,	m	. #	<u>ک</u>	-	60	٥	01	п
	Total Maximum Original Satellite Payload payload total payload EOS orbit final orbit	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Payload description descriptionTotal payload dimensions, fr dimensions, fr foreign domestic communication earth resourcesTotal payload dimensions, fr toreign domestic communication cation plus synchronous earth resourcesIn \times 51 arth resourcesIn \times 51 arth resourcesIn \times 51 arth resourcesIn \times 520 arth resources28.5 28.5 270/270100/100 28.5 28.5 270/27028.5 28.5 270/270100/100 9028.5 100/1001800/180 90 1 A.U./1000	Payload description Total payload dimensions, ft Veright, 1ba 1, deg h / h , n. mi 1, deg 28.5 19 300/19 300 28.5 19 300/19 300 28.5 28.5 270/270 28.5 270/270 28.5 270/270 28.5 270/270 28.5 270/270 28.5 270/270 28.5 270/270 28.5 270/270 28.5 270/270 28.5 28.5 270/270 28.5 28.5 270/270 28.5 28.5 270/270 28.5 28.5 270/270 28.5	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Payload description Potal dimensions	Payload dimensions	Payload description Payload dimensions, ft Veright, 10 a 1, deg h_a/h, n. mi 1, deg h_h, p. n. mi 1, deg 1, deg	Payload description Payload Payload

In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster. DOMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit. Cif minimum propellant usage is assumed, then no ONS offloading would be required.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

			(d) NASA - 1982 - Concluded	- Conclude	pa			
Shuttle	Payload	Total payload	Maximum total payload	Ö	Original EOS orbit	Sat	Satellite final orbit	Booster
flight no.	description	dimensions, ft	weight, lb ^a	1, deg	ha/h, n. mi.	1, deg	ha/hp, n. mi.	required
12	Small applications technical synchronous plus foreign domestic communications	44 × 5.9	16 420	28.5	100/100	0	008 61/008 61	Agena
13	Small applications technical polar plus cooperative applications polar	6.5 × 44	2 820	8	100/100	06	3000/300	2 FW-4S
91-10	General scientific research module sortie	14 × 54	27 500	55	200/200	заше вз	same as EOS orbit	EOS
17-19	General applications module sortie	14 × 51	30 000	65	100/100	same as	EOS orbit	EOS
8	Earth resources sortle	1h × 37	000 9	8	125/125	зате вз	same as EOS orbit	EOS
27	Venus radar mapping	10 × 42	1,2 370	30	001/001	 planetary	- A-	Centaur
22-23	Jupiter Pioneer orbiter	10 × 45	34 370	30	100/100	planetary	_ >_	Centaur
72	Comet rendezvous payload	10 × 35	24 000	30	350/350	planetary	_ h.	EOS
25-30	Crew/cargo	14 × 30	50 000	55	270/270	same as	EOS orbit	EOS
ಜ	U.S. domestic communi- cation plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(d) DOD - 1982

Shuttle flight no.	Payload description	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			EOS
11	D-1	10 × 20	30 000	Centaur
12	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
13	N-2A C-1	5 × 15 9 × 8	1 400 1 100	Centaur
14-15	N-2A	5 × 15	1 400	Agena
16	S-4	9 × 60	10 000	Eos
17-18	S-2B	15 × 25	5 000	Agena
19	C-3B	6 × 7	700	Agena

^aPayloads are defined in classified addendum (ref. 2)

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

		,									
	Booster required	EOS	EOS	Centaur	SOE	Agena	Agena	3 FW-4S	3 FW-45	Centaur	Centaur
	Satellite final orbit eg h/h, n. mi.	same as EOS orbit	same as EOS orbit	1 800/180 20 000/1000 1 A.U./1000	as EOS orbit	as EOS orbit 19 300/19 300	as EOS orbit 30 000/16 000 19 300/19 300	500/500 700/700	200/200	19 300/19 300	00E 61/00E 6T
	Sa fin 1, deg	seme a	same a	000	same s	seme a: 28.5	38me a 29 5	99.15	99.15	0	0
	nal rbit h/h , n. mi.	230/230 200/200 270/270	350/350 200/200 270/270	100/100	350/350 230/230	230/230	350/350	100/100	100/100	100/100	100/100
NASA - 1983	Original EOS orbit 1, deg h	30 28.5 28.5	28.5 28.5 28.5	28.5	30 %	30	28.5	99.15	99.15	28.5	28.5
(e) NASA	Maxium total payload weight, lb	9 920	11 320	37 275	27 000 21 000	15 820	19 720	560 B _q	565 6 _q	43 420	37 615
	Total payload dimensions, ft	14 × 53	14 × 53	10 × 52	14 × 54 14 × 46	34 × 45	14 × 49	12× 40	12× 57	15× 58	10× 55
	Payload description	HESAO revisit plus astronomy sortie plus astronomy explorer	LST revisit plus fluid management sortie plus astronomy explorer	Low magnetosphere explorer plus middle magnetosphere explorer plus high magnetosphere explorer	Large solar observatory (up) high energy stellar sstronomy observatory (down)	HESAO revisit plus foreign domestic communication	LST revisit plus mayigation and traffic control plus mayigation and traffic control	2 Polar earth resources plus TOS meteorological	Polar earth observation plus two polar earth resources	Synchronous meteorological plus applications technology	Synchronous earth resources plus U. S. domestic communication
	Shuttle flight no.	г	8	m	<i>3</i>	ا د	9	-	æ	6	10

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster. DOMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

Booster required	Agena	2 FW-4S	Centaur	EOS	EOS	EOS	EOS	SOG	Agena	Centaur
Satellite final orbit i, deg ha/h, n.mi.	19 300/19 300	3000/300	19 300/19 300	as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	as EOS orbit	19 300/19 300	19 300/19 300
	0	8 8	0	заше	same	same	same	заше	0	0
(e) NASA - 1983 - Concluded Maximum Original Stal payload EOS orbit reight, 1b i, deg ha/hp, n. mi.	100/100	100/100	100/100	200/200	100/100	270/270	100/270 100/270	100/270 100/270	100/100	100/100.
	28.5		28.5	55	65	55	55 55	55 55	28.5	28.5
Maximum total payload weight, lb	16 840	2 600	38 770	27 500	30 000	20 000	22 000 25 000	19 000 33 000	17 240	37 615
Total payload dimensions, ft	ηη × 5·9	6.5 × 28.5	12×60	14 × 54	14 × 51	14 × 30	14 × 32 14 × 45	14 × 38 14 × 58	6.5 × ht	10 × 57
Payload description	Small applications technical synchronous plus comsat	Earth physics plus small applications technical-polar	Follow-on systems demon- stration plus tracking and data relay	General scientific research module sortie	General applications module sortie	Crew/cargo	Physics laboratory (up) earth observation lab (down)	Communications/navigation lab (up) life sciences laboratory (down)	Comsat plus foreign domestic communication	U. S. domestic communi- cation plus synchronous meteorological
Shuttle flight no.	11	12	13-14	15-18	19-20	21-26	27	58	29	30
	Payload payload total payload BOS orbit final orbit dimensions, ft weight, lb i, deg ha/hp, n. mi.	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Payload descriptionTotal payload dimensions, ft synchronous plus comsat polarMeximum total payload dimensions, ft weight, lb applications technical polarTotal dimensions, ft weight, lb applications technical polarMeximum weight, lb applications technical polarOriginal i, deg h/hp, n. mi. ab, deg h/hp, n. mi.Satellite fined poble applications and data relayFollow-on systems and data relay12 × 6038 77028.5100/10090400/400		Payload descriptionTotal payload dimensions, ft dimensions, ft total payload descriptionMaximum payload dimensions, ft weight, lba abiliapplications technical synchronous plus comsatTotal payload dimensions, ft synchronous plus comsatMaximum total payload biliance comsatMaximum total payload biliance comsatMaximum total payload capplications technical capplications technical capplications technical capplications moduleTotal companies capplications module contileMaximum total payload capplications moduleMaximum total payload capplications module contileMaximum contile capplications moduleMaximum total payload capplications module capplications moduleMaximum capplications module capplications moduleMaximum capplications capplications capplications capplications capplications capplicationsMaximum capplications capp		Payload description Total payload dimensions, ft Waximum description Total payload dimensions, ft Weight, lb 1, deg ha/hp, n. mi. 1, deg 1, deg	Payload dimensions, ft veight, lb and some description Payload dimensions, ft veight, lb and description 1, deg ha/hp, n. mi. 1,	Payload Payl

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV

BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED

END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(e) DOD - 1983

Shuttle flight no.	Payload description	Payload dimensions, ft (D × L)	Payload weight, 1b	Tug propellant required, 1b
1-10	None			EOS
11	D-1	10 × 20	30 000	Centaur
12	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
13	N-2A C-2 C-3A	5 × 15 10 × 12 6 × 7	1 400 2 100 700	Centaur
14-15	N-2A C-2	5 × 15 10 × 12	1 400 2 100	Centaur
16	Three M-1	5 × 3 (each)	700 (each)	Agena
17	S-4	9 × 60	10 000	EOS
18	Two S-3	6 × 5 (each) 9 × 20	1 300 2 300	Agena
19	Two S-3	6 × 5 (each)	1 300	Agena
20	S-2B	15 × 25	5 000	Agena

^aPayloads are defined in classified addendum (ref. 2)

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

(f) NASA - 1984

<u> </u>									· · · · · · · · · · · · · · · · · · ·			
Booster	required	EOS EOS Agena	Centaur	Centaur	2 FW-4S	Centaur	BOS	EOS	EOS Centaur + some other kick stage	Agena	SOS	2 FW-bS
Satellite final orbit	ha/hp, n. mi.	as EOS orbit as EOS orbit 19 300/19 300	19 300/19 300 1 A.U./19 300	1800/180 20 000/1000 1 A.U./1000	300/300	19 300/19 300 19 300/19 300	same as EOS orbit	same as EOS orbit planetary	same as EOS orbit planetary	same as EOS orbit 0 19 300/19 300	EOS orbit	500/500 700/700
Sat	i, deg	same as same as 0	28.5 28.5	28.5 28.5 28.5	8 6	% o	Same as	same as E	same as E	same as O	Same as	99.15
Original FOS orbit	h,h,n.mi.	350/350 270/270	100/100	100/100	100/100	100/100	230/230	230/230 350/350	350/350	350/350	350/350	100/100
	1, deg	28.5 28.5	28.5	28.5	06	28.5	30	30	30	28.5	30	99.15
Maximum total mayload	weight, 1b	20 460	37 090	37 270	3 500	36 970	3 500	30 500	37 970+	50 pp2	3 500	006 ¶ _q
Total	dimensions, ft	84 × 41	30 × 45	10 × 52	6.5 × 29	10 × 54	14 × 13	14 × 48	74 × 43+	34 × 41	1½ × 13	6 × 28
Pavload	description	LST revisit plus astronomy explorer plus comsat	Radio explorer plus solar orbit pair - 1 A.U.	Low magnetosphere explorer plus middle magnetosphere explorer plus high mag- netosphere explorer	Gravity/relativity experi- ment C plus small appli- cations technical polar	Solar orbit pair synchronous plus small applications technical synchronous	HESAO revisit	HESAO revisit plus asteroid survey payload	LSO revisit plus asteroid survey booster	LST revisit plus U. S. domestic communications	LSO revisit	Polar earth observation plus TOS meteorological
Shuttle	flight no.	1	α	۳ [.]	a	ľ	9	2	ထ	6	10	ជ

an order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster. DOMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND

(f) NASA - 1984 - Concluded

L								
-	Payload	Total payload	Maximum total payload	υщ	Original EOS orbit	Sa	Satellite final orbit	Booster
	description	dimensions, ft	weight, lb ⁸	1, deg	h/h, n. mi.	i, deg	ha/h, n. mi.	required
Synch	Synchronous earth observa- tion plus planetary relay	9ų × 0ī	16 820	28.5	100/100	0	19 300/19 300	Agena
Appl	Applications technology	15 × 50	75 750	28.5	100/100	0	19 300/19 300	Centaur
Cool	Cooperative applications synchronous plus follow-on systems demonstration	12 × 57	37 290	28.5	001/001	, 0	19 300/19 300	Centaur
Follow	Follow-on systems demon- stration plus tracking and data relay	12 × 60	38 770	28.5	100/100	0	19 300/19 300	Centaur
Gen	General scientific re- search module sortie	14 × 54	27 500	55	200/200	same as	same as EOS orbit	EOS
Gen	General applications module sortie	14 × 51	30 000	65	100/100	same as	same as EOS orbit	EOS
Ded	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55	200/200	same as	EOS orbit	EOS
Ded	Dedicated applications module earth observation sortie	14 × 41	22 500	75	100/100	same as	EOS orbit	EOS
Sta	Station module-core	07 × 71	20 000	55	270/270	Same as	same as EOS orbit	EOS
క	Crew/cargo	14 × 30	20 000	55	270/270	same as	EOS orbit	EOS
	U. S. domestic communication plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur
	meteorological							

An order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

Since the tug becomes available in 1985, EOS flights for years 1985 through 1990 are the same as those defined in table V.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR AV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Concluded

(f) DOD - 1984

Shuttle flight no.	Payload description ^a	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, 1b
1-10	None			EOS
11	D-1	10 × 20	30 000	Centaur
12	N-2B N-2A	5 × 15 . 5 × 15	1 400 1 400	Centaur
13-14	N-2A C-2	5 × 15 10 × 12	1 400 2 100	Centaur
15	N-2A C-3A	5 × 15 6 × 7	1 400 700	Agena
16.	Three M-1	5 × 3 (each)	700 (each)	Agena
17	S-4	9 × 60	10 000	EOS
18-19	S-2A	15 × 25	5 000	Centaur

^aPayloads are defined in classified addendum (ref. 2).

Since the tug becomes available in 1985, EOS flights for years 1985 through 1990 are the same as those defined in table V.

TABLE VII.- EOS FLIGHTS ASSOCIATED WITH TWO TUG AVAILABILITY TIMES, 1979 AND 1985

1990 Total	71 p	52 564	17 1/30	52 578	20 218	23 247	20 212	23 254
1989	84	₹5	81	ης	71	23	17	21
1988	7	58	717	58	20	52	20	22
1987	94	25	917	55	23	52	23	52
1986	94	52	97	52	20	ηz	20	772
1985	20	62	50	62	21	82	27	22
1984	39	9†	33	L ₁	22	52	13	25
1983	39	52	30	52	ħ Z	62	50	30
1982	35	1,5	31	91	เร	23	61	ส
1981	3,4	917	ηε	5.1	16	18	16	19
1980	† ∂	32	21	†ε	12	15	15	50
6161 _q	9	10	9	21	٥,	8	2	cı .
81978								·
Mode	XASA	NASA payloads	NASA	NASA payloads	DOD		םסם	8
Description	Tug available	loads placed NASA end-to-end payload	Tug available	loads placed lend-to-end	Tug available DC	loads placed end-to-end	Tug available	loads placed end-to-end

⁹Three dedicated NASA and one dedicated DOD flights for the year 1978 will be defined by NASA Headquarters and are not included in this table.

^bFour dedicated NASA and two dedicated DOD flights for the year 1979 will be defined by NASA Headquarters and are not

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE

FLIGHTS BY INCLINATION

(a) NASA - tug available in 1979 and payloads stacked end-to-end

			Inclina	tion		`	
Year	28.5	30	55	65	75	a90-101	Total
1979	5	1					6
1980	18	3		 		3	24
1981	12	ъ3	13	2		4	34
1982	9	. 7	9	3		7	35
1983	16	3	12	2		6	39
1984	15	5	12	3	2	2	39
1985	13	6	20	2	2	7	50
1986	12	7	16	3	2	6	. 46
1987	16	7	15		2	. 6	46
1988	17	6	14	3	2	2	71,71
1989	12	9	15	ı	3	8	48
1990	11	6	15		4	5	41
Total	156	63	141	19	17	56	452
Percent	34.5	13.9	31.2	4.2	3.8	12.4	100.0

^aFor sun synchronous orbits, the EOS carries the tug plus payload to a 100-n. mi. circular orbit at an inclination of 90° and the tug is used to make the plane change.

Many DOD flights do not have an inclination defined; thus the total number of flights for this table does not correspond to values found in other sections of the report.

bTwo flights contain a 30° payload combined with a 28.5° payload.

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE

FLIGHTS BY INCLINATION - Continued

(a) DOD - tug available in 1979 and payloads stacked end-to-end

		Incl	ination		
Year	28.5	30	63.4	90-101	Total
1979			·		
1980	3	1	1	2	7
1981	. 2		1	3	6
1982	2	4	2	2	10
. 1983	3	14	2	Ц	13
1984	5	14		2	11
1985	3		2	5	10
1986	2	<u>}</u>	. 1	2	9
1987.	4	14		4	12
1988	2	4	2	1	9
1989	1.		ı	Ъ,	6
1990	4	4		1	9
· Total	31	29	12	30	102
Percent	. 30.4	28.4	11.8	29.4	100

TABLE VIII. - NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS

BY INCLINATION - Continued

(b) NASA - tug available in 1985 and payloads stacked end-to-end

				Inclin	ation			
Year	28.5	30	55	65	75	90	Sun synchronous	Total
1979	5	ı						6
1980	15	3.				2	1	21
1981	13	а. З	12	2		b ₂	2	34
1982	6	c ₈	9	3,		4	1	31
1983	11	d ₂	12	2		ı	2	30
1984	10	4	12	3	2	1	1	33
1985	13	6 -	20	2	2	7		50
1986	12	7	16	3	2	6		46
1987	16	7	15		2	6		46
1988	17	6	14	3	2	2	·	717
1989	12	9	15	ı	3	8		48
1990	11	6	15		4	5		41
Total	141	62	140	19	17	44	7	430
Percent	32.8	14.5	32.6	4.2	3.8	10.3	1.7	100.0

^aTwo flights contain a 30° payload combined with a 28.5° payload.

Many DOD flights do not have an inclination defined; thus the total number of flights for this table does not correspond to values found in other sections of the report.

One flight contains a sun synchronous payload.

^CThree flights contain a 30° payload combined with a 28.5° payload.

done flight contains a 30° payload combined with two 28.5° payloads.

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS

BY INCLINATION - Continued

(b) DOD - tug available in 1985 and payloads stacked end-to-end

		Inc	lination		
Year	28.5	30	63.4	90-101	Total
1979					
1980		2	1	2	5
1981	.3	j	1	2	6
1982		4	2	2	8
1983		4	1	4	9
1984	2	4]	2	8
1985	3		2	5	10
1986	2	4	1	2	9
1987	4	4		4	12
1988	2	4	2	1	9
1989	1		1	4	6
1990	կ	4		1	9
Total	21	30	11	29	91
Percent	23.1	33.0	12.1	31.8	100

TABLE IX. - TOTAL PAYLOAD TO ORBIT (LB)

(a) NASA - tug available in 1979 and payloads stacked end-to-end

)					
Year			Incli	Inclination			
	28.5	30	55	65	15	⁸ 90	Total
1979	175 780	21 000		·		-	196 780
1980	625 170	51 340				38 400	714 910
1981	481 045	l ₄ 7 280	280 910	000 09		54 995	924 230
1982	380 820	217 130	202 500	000 06		118 465	1 008 915
1983	727 290	55 000	329 000	000 09		71 360	1 242 650
1984	581 355	75 575	279 500	000 06	145 000	33 095	1 104 525
1985	266 550	234 650	513 395	000 09	145 000	85 490	1 505 085
1986	180	74 585	360 000	000 06	145 000	106 380	1 167 145
1987	710 005	95 270	347 500		145 000	71 360	1 269 135
1988	691 780	223 440	354 000	000 06	145 000	37 670	1 441 890
1989	786 550	143 355	362 910	30 000	67 500	95 610	1 185 925
1990	493 585	141 000	341 500		000 06	103 360	1 169 445
Total	011 114 9	1 379 625	3 371 215	570 000	382 500	816 185	12 930 635

 $^{\rm a}_{\rm Sun}$ synchronous payloads plus tugs were offloaded at an inclination of $90^{\rm o}$ and the tug performed the plane change.

TABLE IX.- TOTAL PAYLOAD TO ORBIT (LB) - Continued

(a) DOD - tug available in 1979 and payloads stacked end-to-end

		Inclina	tion		·
Year	28.5	30	63.4	90-99	Total
1979					
1980	144 144	75 156	30 574		276 273
1981	118 558		25 568	55 367	199 453
1982	95 760 :	150 312	61 148	38 968	346 188
1983	151 171	150 312	56 142	52 417	410 042
1984	269 729	150 312		26 399	446 440
1985	157 248	ı	61 148	61 009	279 405
1986	98 018	150 312	30 574	45 669	324 573
1987	219 763	150 312	:	69 367	439 442
1988	99 735	150 312	61 148	13 009	324 204
1989	53 153		30 574	53 408	137 117
Total	1 625 572	1 127 340	356 876	458 411	3 568 199

TABLE IX. - TOTAL PAYLOAD TO ORBIT (LB) - Continued

NASA - tug available in 1985 and payloads stacked end-to-end (<u>a</u>

				Inclination	tion			
Year	28.5	30	55	. 59	75	96 ₈	Sun syn- chronous	Total
1979	130 385	21 000						151 385
1980	339 790	42 470				8 600	006 17	395. 760
1981	336 705	0/1 61	270 620	000 09		25 120	16 190	757 805
1982	166 635	197 610	202 500	000 06		33 740	006 7	695 385
1983	320 825	55 000	329 000	000 09		2 600	17 690	785 115
1984	325 150	75 470	279 500	000 06	145 000	3 500	7 900	823 520
1985	266 550	234 650	513 395	000 09	η ₅ 000	85 490		1 505 085
1986	491 180	74. 585	360 000	000 06	145 000	106 380		1 167 145
1987	710 005	89 270	347 500		145,000	71 360		1 263 135
1988	691 180	223 440	354 .000	000 06	h5 000	37 670		1 441 890
1989	486 550	143 355	362 910	30 000	67 500	95 610		1 185 925
1990	493 585	141 000	341 500		90 000	103 360		1 169 445
Total	5 059 140	1 347 020	3 360 925	570 000	382 500	573 430	48 580	11 341 595.

 $^{
m a}_{
m From}$ 1985 on sun synchronous payloads plus tugs were offloaded at an inclination of $90^{
m o}$ and the tug performed the plane change.

TABLE IX.- TOTAL PAYLOAD TO ORBIT (LB) - Concluded

(b) DOD - tug available in 1985 and payloads stacked end-to-end

		Inclin	ation		
Year	28.5	30	63.4	90-99	Total
1979					
1980		45 957	14 879	14 797	75 633
1981	62 308		11 675	14 797	88 780
1982		61 836	29 758	15 765	107 359
1983		99 090	14 879	35 552	149 521
1984	52 146	87 370		14 797	154 313
1985	157 248		61 148	61 009	7 279 405
1986	98 018	150 312	30 574	45 669	324 573
1987	219 763	150 312	į	69 367	439 442
1988	99 735	150 312	61 148	13 009	324 205
1989	53 153		30 574	53 408	137 135
1990	218 293	150 312			385 004
Total	960 664	895 501	254 635	354 569	2 465 369

TABLE X.- ENERGY STAGES REQUIRED

(a) NASA - tug available in 1979 and payloads loaded end-to-end

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Tug flights Tugs expended	mc	16	9t .	91	18	15	21	16 8.2	19	20	19	15	194
Centaurs expended	0	10	10	0	10	٠ _۲	10	۰.	10	10	10	٦ ^۲	10
Agenas expended	0	0	0	0	0	0	0	0	0	0	0	0	0
FW-4S expended	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of orbital assemblies	0	0	0	п	a	н	٣	н	ď	-	8	α	15
						,							_

Rull usage is not made of tugs because they are required to be expended before nominal end of lifetime. bCentaur plus another kick stage.

(a) DOD - tug available in 1979 and payloads loaded end-to-end

	1979	1980 1981		1982	1983	1987	1985	1986 1987 1988	1987	1988	1989	1990	Total
Tug flights	0	9	5	10	13	77	10	10	п	10	5	10	86
Tugs expended	0	0	0	н	0	н	H	0	н	н	0	н	9
Centaurs expended	0	0	0	0	0	0	0	0	0	0	0	0	0
Agenas expended	•	0	0	. 0	0	0	0	0	0	0	0	0	0
FW-4S expended	•	0	0	0	0	0	0	0	٥.	0	0	0	0
Number of orbital assemblies	0	0	0	0	0		0	0	0	0	0	0	0

TABLE X .- ENERGY STAGES EXPENDED - Concluded

9,0000 (b) NASA - tug available in 1985 and payloads loaded end-to-end Centaurs expended Agenas expended FW-4S expended Number of orbital assemblies

Tug flights Tugs expended

Total

8 39 20 27 13

200 d

^aFull usage is not made of tugs because they are required to be expended before nominal end of lifetime.

^bCentaur plus another kick stage.

Cone flight requires Centaur plus another kick stage.

(b) DOD - tug available in 1985 and payloads loaded end-to-end

			,			•							
	1979	1980 1981	1981	1982	1983	1984	1983 1984 1985	1986 1987	1987	1988	1989	1990	Total
Tug flights	0	0	0	0	0	0	L	70	11	10	5	10	53
Tugs expended	, 	0	•	0	0	0	0	7	0	н	0	1	8
Centaurs expended	۸.	6	12	13	15	16	0	0	0	0	0	0	67
Agenas expended	<i>o</i>	н	m	۲۷	. 7	Q	0	0	0	0	0	0	15
FW-4S expended	0	0	0	•	0	0	0	0	0	0	0	0	0
Number of orbital assemblies	。 —	0	0	0	0	0	0	0	0	0	0	0	0
									-				

	Total	270	248	91	98		₄ 59	437		221	215		680	652
	1990	22	22	10	6		τ _ή	[1]		50	80		61	61
	1989	33	31	8	6		84	84		17	17		65	65
	1988	25	25	6	10		17.17	77		50	20		1 9	64
EAR	1987	59	29	10	7		911	91		23	23		69	69
S PER Y	1986	25	25	12	6		917	91		50	20		99	99
FLIGHT	1985	28	28	12	10		8	20		ส	21		77	17
SHUTTLE	1981	22	16	7	10		33	33		22	19		61	52
ORBIT	1983	23	17	8	8		33	8		772	50		63	50.
F EARTH	1982	19	15	9	10		35	æ		ส	19		95	20
UMBER O	1981	Lτ	71	6	8		34	3†		91	16		20	20
TABLE XI NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS PER YEAR	1980	18	15		. 9		77	21		12	. 15		36	36
TABLE	b ₁₉₇₉	8	8		2		01	10		4	17		1,4	14
	8 ₁₉₇₈	. ه	ю				ო	3		ч	1		4	্ৰ
	Earth orbit shuttle flight description	MASA satellite placement Tug available in 1979 - end-to-end stacking	Tug available in 1985 - end-to-end stacking	NASA space station	NASA sorties	Total NASA	Tug available in 1979 - end-to-end stacking	Tug available in 1985 - end-to-end stacking	Total DOD missions	Tug available in 1979 - end-to-end stacking	Tug available in 1985 - end-to-end stacking	Total of NASA and DOD	Tug available in 1979 - end-to-end stacking	Tug available in 1985 - end-to-end stacking

ancludes the first 10 flights to be defined by NASA Headquarters.

TABLE XII. - NUMBER OF FLIGHTS REQUIRING OFFICADING OF OMS OR REMOVAL OF ABES

(a) NASA - tug available in 1979 and payloads loaded end-to-end

	ago Total	Both OMS	6	2 0			13	;	- v-	3 1 10 1		2 15 1	- FT	3 8	3th 6
ation	75	OMS ABES Both							_						
Inclination	65	OMS ABES Both													
	55	OMS ABES Both C			-					-		7			1
	30	OMS ABES Both							2	7		<u>м</u>	7		6
	28.5	OMS ABES Both	3	10		9	6	2		9	12	10		6	89
	Tegr		1979	1980	1981	1982	1983	1984	1985	1986	1987		1989	1990	Total

i

Sun sychronous payloads plus tugs were offloaded at an inclination of 90° and the tug performed the plane change.

TABLE XII.- NUMBER OF FLIGHTS REQUIRING OFFICADING OF OMS OR REMOVAL OF ABES - Continued
(a) DOD - tug available in 1979 and payloads loaded end-to-end

					.							Inclination	tion											
Year		8			2			300		_	63.4°			%			970			°66			Total	
	CIMIC	ABES	Both	SMS	ABES	Both	CIMIS	ABES	Both	OMS /	ABES	Both	SMO	ABES	Both	SMS	ABES	Both	OM S	ABES	Both	OMS	ABES	Both
1979	0	0	ó	0	0	0	0	0	0	0	0	0	0	0	0	0	0	۰	•	0	0	•	0	•
1980	-	0	•	0	0	0	0	0	0	•	0	0	.0	0	•	0	•	0	-	0	0	ď	0	0
1981	N													-				_	-1			м	٦	0
1982													-	r4								0	7	0
1983	N						•						٥ı									'n	0	0
1984	æ													-					1			۰	•	0
1985	CV.												-									м	•	0
1986	7													н					٠,			ď	7	0
1987	е													-								4	٦	0
1988	7												-	····								ď	۰	0
1989	1											-	7									м	0	0
1990	3																		1			4	0	0
Total	8	0	0	0	0	0	0	0.	0	0	0	0	5	5	0	0	0	0	80	0	0	33	9	0

TABLE XII.- NUMBER OF FLIGHTS REQUIRING OFFLADING OF OMS OR REMOVAL OF ARES - Continued

(b) NASA - tug available in 1985 and payloads loaded end-to-end

<u> </u>	T	Į.g.	7												İ
	1	Both	1												_
	Total	ABES								-		٦		N	ي ا
		OMS			m	~	٥			2	16	15	ដ	0/	ŕ
	smo	Both													
	Sun synchronous	ABES													
	, g	OMS		н	ď	н	ď	٦							~
		Both											-		
	8	ABES								п				ď	Е
 		SMO			L	a,			~	м	. 	N	٧.	ъ	54
		Both		·	**										
	75	ABES				-						_			
Inclination		OMS													
Incli		Both													
	65	ABES	T	-											
-		OMS													
		Both					_	-			_				
	55	ABES										-			7
		OMS									-				
		Both													
	30	ABES			`		-								
		OMS							2	-		<u>س</u>	н		~
		Both												1	_
	28.5	ABES												1	\dashv
		SWC	-						80	9	12	2	-	9	67
	Year		1979	1980	1981	1982	1933	1987	1985	1986	1981	1988	1989	1990	Tctal
			ட்											ᆜ	

alf minimum booster fuel usage were assumed, no OMS offloading would be required.

TABLE XII.- KUMERN OF FLIGHES REQUIRING GFFLANDING OF OMS OR REMOVAL OF ARES - Concluded (b) DOD - tug available in 1985 and payloads loaded end-to-end

												Inclination	tton											
		-			٦			8			63.4			8			97			8			Total	
Year	S963	ABES	Both	8	ABES	Both	3	ABES	Both	SHE	ABES	Both	CIMES	ABES	Both	S	ABBS	Both 0	OMES A)	ARRS B	Both	SIMO	ABES	B th
1979																		_						
1980																								
1961																	_	_		_		_		
1982													,	•										
1983																							-	
1961																						_		•
1985	N												٦							-		m		
1986	-													-					_			N	-	•
1961														-			•		_				7	
1988	-												-			_		_				~		
1989	7				•													-	٦			8		
1990	3									7			-				7	1	_	+	+	~	1	ļ
Total	п												m	-3		•	•		<u>.</u>			18	-	
										٦								1	\dashv	\dashv	\dashv	1	1	

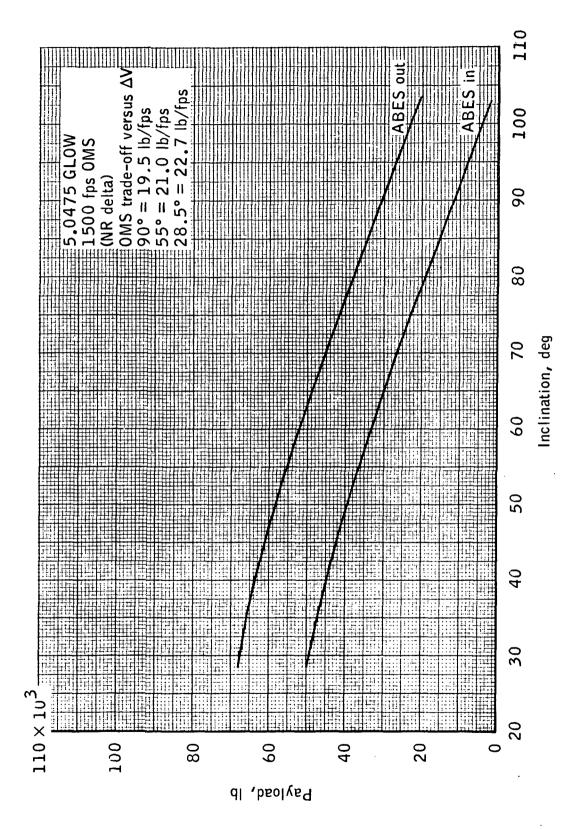


Figure 1.- Earth orbit shuttle payload capability versus inclination.

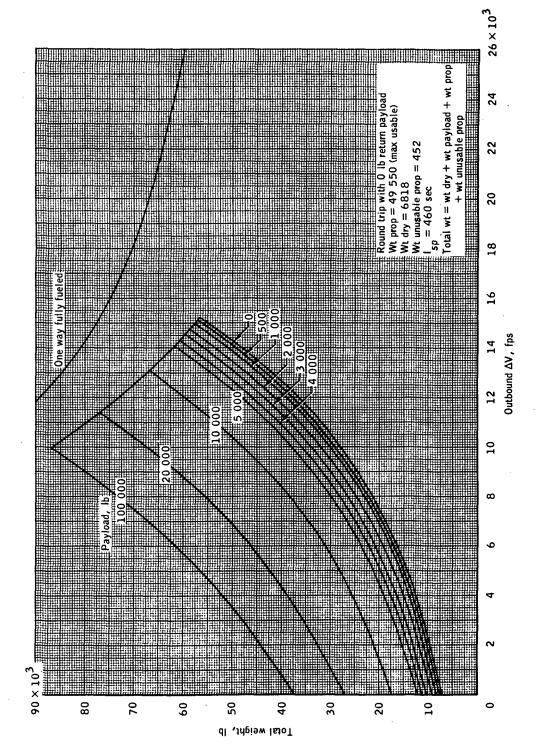


Figure 2.- Tug capability curves.

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